Chapter 7 Case Study

7.1 Preparation and Implementation of the Case Study

Target mines for the case study are listed in 1.6.2 in Chapter 1. Target mines selected in the Inception Report for the case study were impossible to study due to the rapid progress of privatization. Therefore, new targets were selected, based on discussion among the Ministry of Economy, Agency of Privatization, MEM and the Study Team. Mines and tailings ponds selected here belonged to bankrupt companies waiting for arbitration by the supreme court, or facilities that were not being privatized. The Agency of Privatization has mine data to analyze these selected mines (Grot and Suva Ruda). Therefore, the case study was carried out under limited availability of mine data. The case study was implemented during the 2nd and 3rd local surveys.

Tailings ponds selected for the case study were from the RTB Bor (not privatized), and Lece Mine.

It should be noted that sampling of active processing plants was done in the Grot and Rudnik mines to evaluate mineral processing.

(1) Requesting Proposals for Local Consultant (LC)

The Team explained to the Copper Institute Bor (CIB), Faculty of Technology and Metals/University of Belgrade (TMF) and the Geophysical Institute (GFI) that the case study would involve the execution of core drilling and sampling from tailings dams and operating processing plants, execution of processing tests and analysis and interpretation before the beginning of the site survey. The Team required them to submit proposals and received them.

(2) Price Negotiation, Conclusion of Contract

The Team selected CIB as a LC after a couple of negotiations on the proposals and concluded.

(3) Confirmation of the Core Drilling and Sampling Points

The Team confirmed with LC the following core-drilling and sampling points of the tailings dams and sampling points of the processing plants:

- Core-drilling and sampling points at the old tailings dam of Bor with LC (8 points),
- Core-drilling and sampling points at the tailings dam of Leće with LC (8 points)
- Sampling points at the processing plant of Grot Mine with LC (4 points)
- Sampling points at the processing plant of Rudnik Mine with LC (4 points)
- Currently sampling data are being analyzed.

7.2 Geology, Deposits and Exploration

7.2.1 Grot Mine

(1) Geology and Deposits

This area is located in the Besna Kobila-Osogovo metallogenic zone of the

Serbo-Macedonian metallogenic province. Important lead and zinc deposits occur in the metallogenic zone that runs 50 – 60km north to south. Gneiss, crystalline limestone, carbonaceous schist of Early Paleozoic (Ordovician to Silurian), and biotite-sericite schist and mica schist of Late Paleozoic overlie the Blagodat ore field, and Tertiary granodiorite, andesite and dacite intrude the strata.

The Blagodat ore field is comprised of skarn-type lead and zinc deposits and vein-type zinc deposits, which formed in crystalline limestones and carbonaceous schists intruded by dacite-andesite and granodiorite. The ore field covers an area of 3km east to west and 4km north to south (Fig.7.1). Around the orebodies, main fractures oriented NW-SE and secondary fractures trending NE-SW crossing main fractures have developed. Dykes of dacite–andesite ranging in length from 1m to 15m intrude NW-SE.

The Grot mine (formerly the Blagodat mine) includes the Blagodat, Đavolja Vodenica, Vučkovo, Đavolja Vodenica II, and Kula deposits (Fig.7.2). The Blagodat, Đavolja Vodenica、Vučkovo, and Đavolja Vodenica II are skarn-type deposits, and the Kula is a vein type. From 1974 to 2005, the Blagodat – Grot mine produced a total of 5.2 million tones of crude ore grading 2.9%Pb and 2.7% Zn.

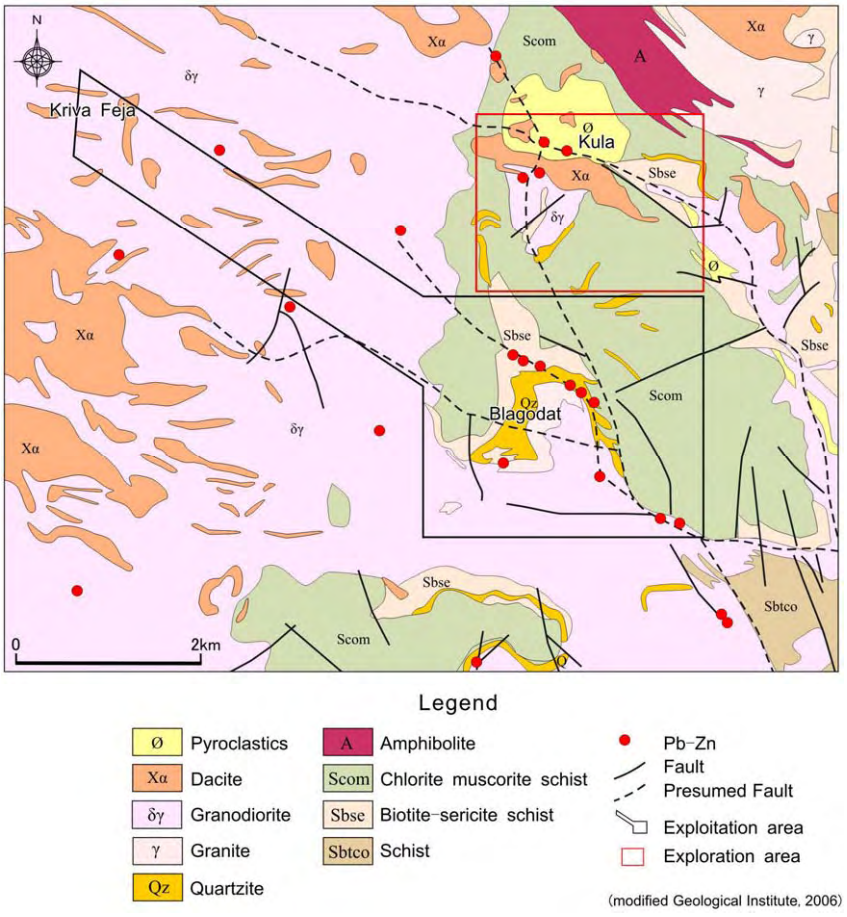


Fig.7.1 Geological Map of the Blagodat Ore Field

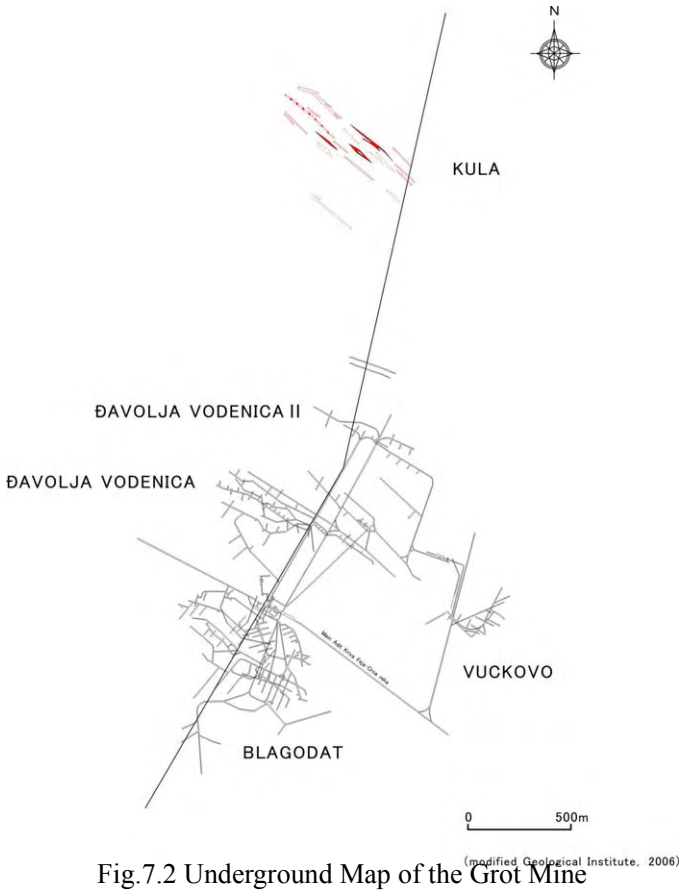


Fig.7.2 Underground Map of the Grot Mine

(a) Skarn-type Deposits

Skarn-type lead and zinc orebodies of the Blagodat, Đavolja Vodenica, Vučkovo, and Đavolja Vodenica II deposits form stratiform and lenses controlled in crystalline limestone, and are partly disseminated (Fig.7.3 and Fig.7.4). There are clear boundaries between skarn orebodies and the hanging wall (crystalline limestone of country rock of skarn) and footwall (silicified gneiss) (Fig.7.5).

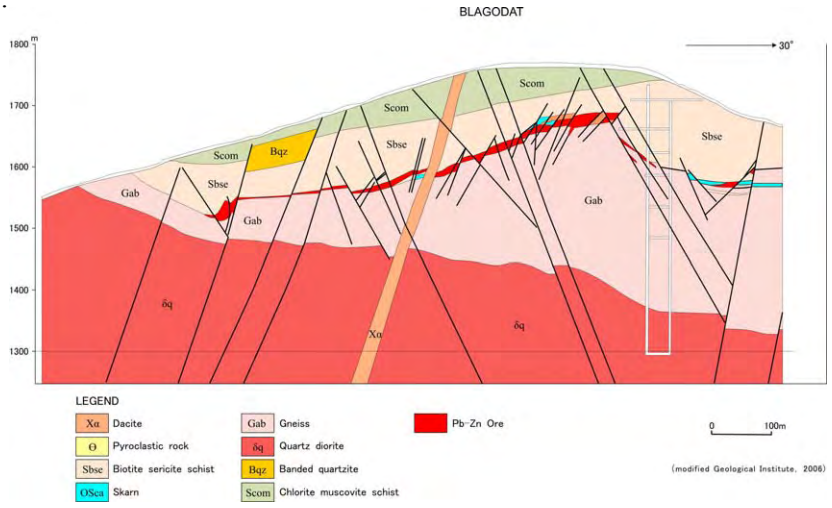


Fig.7.3 Geological Profile of the Blagodat Deposit

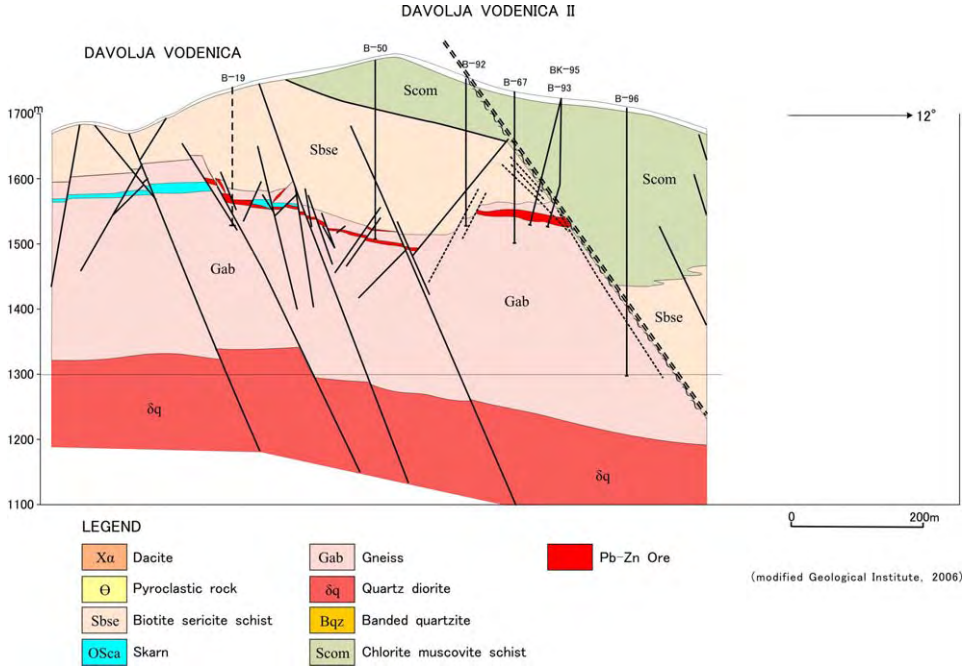


Fig.7.4 Geological Profile of the Đavolja Vodenica and Đavolja Vodenica II Deposits

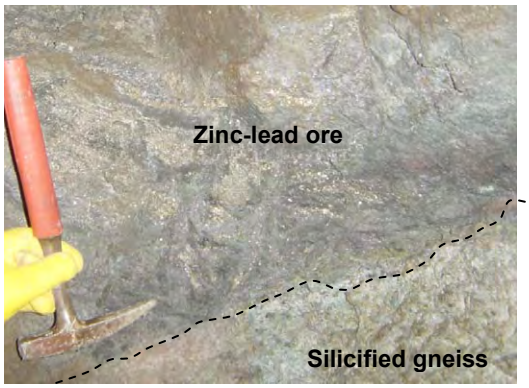


Fig.7.5 Occurrence of Lead & Zinc Skarn Ore
(At 1,518mL of the Đavolja Vodenica Deposit)

The No. 2 orebody of the Blagodat deposit, the champion orebody, is 400m long and from 20m to 30m wide, and runs NW-SE. The orebody continues from 1,680m asl to 1,538m asl, 150m in vertical length. Other orebodies range from 10m to 15m long, 1m to 3m wide, and 5m thick.

Ore grade varies from 7 – 8% lead and zinc (low grade) to 20 – 30% lead and zinc (high grade). High-grade ores tend to occur in the central part, with low-grade ores surrounding them.

The main ore minerals are galena, sphalerite, magnetite and pyrite. Secondary minerals include pyrrhotite, chalcopyrite and cubanite. Skarn minerals consist mainly of clinopyroxene, epidote and chlorite, with small amounts of garnet and wollastonite.

(b) Vein-type Deposits

The Kula deposit is a vein type that is located 3km north of the skarn deposits. About 10 veins occur in an area of 700m east to west, and 600m north to south. All the veins strike N40 ° W and dip 75 ° to 80 ° to the east (Fig.7.6).

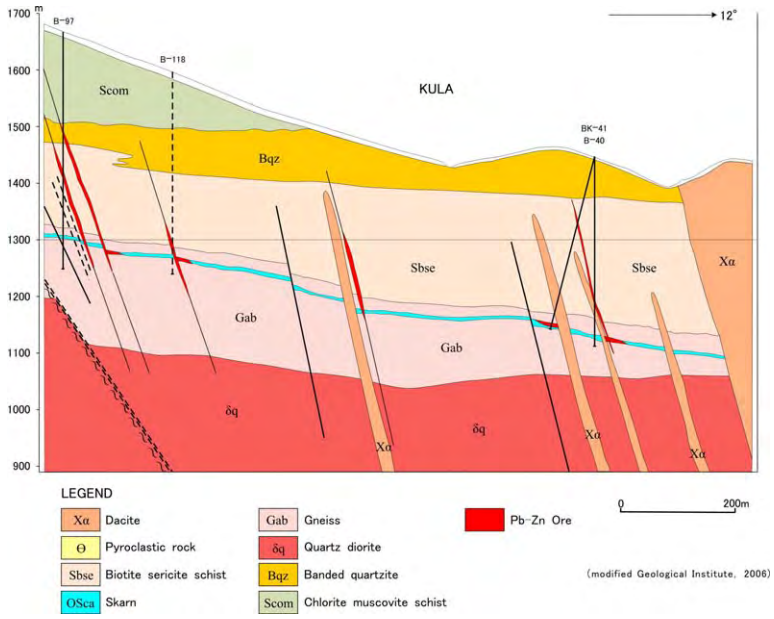


Fig.7.6 Geological Profile of the Kula Deposit

The scale of veins ranges from 100m to 250m long, and maximum 3m wide. Parts of veins have formed echelons. Ore shoots of veins are oriented toward N50 ° – 60 ° E, and incline 20 ° –30 ° east. Ore grade ranges from 7 % to 8% Pb and Zn. The main ore minerals are galena, sphalerite, magnetite and pyrite.

(2) Prospecting

Prospecting basically includes surface drilling, tunneling (adits and drifts) and underground drilling. Geophysical surveys using two drifts spaced 500m or less apart, are carried out where orebodies are presumed to exist. Capacity of drilling machine is 300m, and drills can go 360 degrees in both the horizontal and vertical directions.

Total length of underground drilling prospecting was 1,500m to 2000m in 2005, and 3,500m in 2006 based on a plan for 5,600m. The mine has planned 5,000m of drilling in 2007, at the Đavolja Vodenica and Đavolja VodenicaII deposits. However, detailed planing maps are not available.

(3) Reserves

From 1974, when the Grot mine started operation, until 2005, the mine produced 5.2 million tonnes of crude ore with 2.94% Pb and 2.67% Zn, and 154,000 tonnes of lead and 140,000 tonnes of zinc (Geological Institute, 2006). Ore reserves at 31 December 1987, which is the latest data available for the mine, amounted to 113,000 tonnes with 6.14% Pb, 4.64% Zn and 188g/t Ag in classes A+B+ C1.

Ore reserves at 31 December 2005, amounted to 345,000 tonnes with 4.84% Pb and 5.57% Zn in A+B+C1 category. At that time, probable resources (C2) were estimated to be 5.0 million tonnes (Table 7.1 and Table 7.2.)

Table 7.1 Reserves of the Grot Mine (as of 31.12 2005)

Ore deposit	Category	Category (Western)	Category (Serbian)	Reserves t	Pb grade %	Zn grade %	Pb t	Zn t
Blagodat	Geological reserves	Proven	A	115,028	5.44	4.72	6,258	5,429
	Geological reserves	Proven	B	–	–	–	–	–
	Geological reserves	Proven	C1	–	–	–	–	–
			A+B+C1	115,028	5.44	4.72	6,258	5,429
Davolja Vodenica	Geological reserves	Proven	A	–	–	–	–	–
	Geological reserves	Proven	B	58,940	3.18	4.50	1,872	2,653
	Geological reserves	Proven	C1	20,794	3.55	4.90	737	1,020
			A+B+C1	79,734	3.27	4.61	2,610	3,673
Vuckov	Geological reserves	Proven	A	38,836	4.05	5.19	1,573	2,016
	Geological reserves	Proven	B	50,997	5.71	9.64	2,915	4,712
	Geological reserves	Proven	C1	20,803	4.54	5.45	944	1,135
			A+B+C1	110,636	4.91	7.11	5,431	7,862
Davolja Vodenica II	Geological reserves	Proven	A	–	–	–	–	–
	Geological reserves	Proven	B	25,563	6.47	6.46	1,655	1,653
	Geological reserves	Proven	C1	14,915	5.27	4.44	786	663
			A+B+C1	40,478	6.03	5.72	2,441	2,315
Total	Geological reserves	Proven	A	153,864	5.09	4.84	7,830	7,445
	Geological reserves	Proven	B	135,500	4.75	6.66	6,442	9,018
	Geological reserves	Proven	C1	56,512	4.37	4.99	2,467	2,817
			A+B+C1	345,876	4.84	5.57	16,739	19,280

Table 7.2 Resources of the Grot Mine (as of 31.12 2005)

Area	Location	Category (Western)	Category (Serbian)	Resources t	Pb grade %	Zn grade %	Pb t	Zn t
Kula	P–I	Probable	C2	1,254,866	3.20	3.80	40,156	47,685
South of Davolja Vodenica	P–II1	Probable	C2	45,000	3.20	4.60	1,440	2,070
West of Davolja Vodenica	P–II2	Probable	C2	27,000	3.20	4.60	864	1,242
Vuckov	P–II3	Probable	C2	405,000	4.90	7.10	19,845	28,755
South of Davolja Vodenica II	P–II4	Probable	C2	112,500	6.00	5.70	6,750	6,413
North of Davolja Vodenica II	P–II5	Probable	C2	900,000	6.00	5.70	54,000	51,300
Southwest of Kula	P–II6	Probable	C2	756,000	3.20	3.80	24,192	28,728
Between Kula and Davolja Vodenica	P–III	Probable	C2	1,560,000	4.60	4.70	71,760	73,320
Total				5,060,366	4.33	4.73	219,007	239,512

(4) Issues

Seven years ago, geological staff in the mine consisted of 4 geologists and 3 assistants. However, in the current structure there are only one geologist and one assistant. No underground maps have been compiled though the trackless underground method had been used to dig prospecting and developing tunnels during the last 2 years. There is no basic map for grade control. Production control of crude ore is insufficient due to the total lack of assay maps of new prospecting regions.

Calculation of ore reserves in the Grot mine has been done by the Geological Institute, which is qualified to assess ore reserves on the basis of the geological prospecting regulations. Reserves and ore grade of mines in Serbia are determined by the Reserves Verification Commission and even under the market economy the reserves and grade are still under state control. In a market economy, the government should take measures to reduce state control. Specifically, the government should establish the rules for estimating ore reserves, but mining companies should make the actual assessments based on these rules, and the system for certifying the reserves and grade should be changed from approval by the government to reporting to the government. It appears that a mining company or development company will assume the risks associated with

finding reserves when a mine is being exploited.

Underground geological maps are insufficient, as are formation and structural analyses of deposits, due to the reductions in staff and lack of time to study the analyses. There is no chance to acquire new information as mining geologists lack knowledge of ore shoots. Because there are no underground distribution maps of ore deposits, underground prospecting and underground drilling are not conducted efficiently or systematically.

The short-term prospecting plan for the 5 million tonnes of estimated resources shown in Table 7.2, is not specific and diagrammed. The expected mine life is 3 years, based on 300,000 tonnes of ore reserves that are extracted at a rate of 100,000 tonnes per year.

(5) Mineral Potential, Measures and Recommendations

The areas having particular mineral potential include the vicinity of the Đavolja Vodenica II deposit, the area around the Kula deposit and a sector between the Đavolja Vodenica II and Kula deposits. In future, underground drilling and drift prospecting will be needed in these areas. Optimally, this would involve detailed underground drillings of the 200 – 400m class and drift prospecting of the 1000 – 1500m class toward the presumed ore deposits in these areas. However, the Grot mine cannot afford exploration due to its present financial difficulties. Therefore, it would be desirable for the government to create a new system for supporting exploration through subsidies.

It is important to secure ore reserves not only at Grot, but at any mine, because ore reserves will determine the life of the mine. At present, there is an estimated 5 million tonnes of resources in the abovementioned area in the Grot mine. The 5 million tonnes is the same amount of ore that had been excavated for approximately 20 years since 1974. Given the current high prices in the zinc and lead markets, this would be an excellent time to restart exploration activities. Exploration would also make a considerable contribution to the reconstruction of the Grot mine.

Estimates have already been made of ore reserves which can be obtained by drilling prospects around the deposits, assuming that the interval between drill holes is 50m, average length of drilling is 300m and 16 holes are drilled each year. After drilling a prospect around a deposit, mineralization of 30m in length would be hit per 300m of drill hole. The probability of hitting mineralization with each drill hole would be 1/5, meaning that an annual average of 3.2 drill holes (16/5) would find mineralization. In this scenario, the estimated total amount of ore reserves would be 58,000 tonnes per drill hole X 3.2. This estimate is derived from the following formula:

Per 300m long mineralized drill hole ------ 30m (length) x 25m (width) x 25m (height) x 3.1(t/m^3) = 58,000t per drillhole X 3.2.

It is assumed that the ore reserves that are obtained will be reduced at an annual rate of 20% due to the reduction of areas for exploration.

Table 7.3 shows estimated values for ore reserves based on the assumptions that mining recovery is 0.76%, dilution is 18% and the amount of mined ore is at the same level (100,000 tonnes) as in 2006.

Table 7.3 Target Reserves to be Explored at the Grot Mine (unit: Kt)

	1st year	2nd year	3rd year	4th year	5th year	Total
Minable ore reserves	345	364	396	372	332	
Mined ore*	100	100	100	100	100	500
Obtained ore reserves	185	148	118	94	75	620
Obtained minable ore	119	132	76	60	48	435
Crude ore at year-end	364	396	372	332	280	

In this estimation, 620,000 tonnes would be obtained, compared with 500,000 tonnes of ore that would be mined over a 5-year period. It is considered that approximately 5000m total length (300m X 16) would be a suitable amount of annual drill prospecting.

7.2.2 Suva Ruda Mine

(1) Geology and Deposits

This area is located in the Raska ore zone of the Serbo-Macedonian metallogenic province. In the ore zone, lead and zinc deposits occur in an area running 10km east to west, and 20km north to south. Tertiary volcanic rocks overlie the Raska ore zone, and consist mainly of andesitic-dacitic volcanic rocks and granodiorite. The eastern and western ends of the ore zone contact with serpentinite of the Jurassic period. Mineralization has been affected by lithology and structure, as a number of deposits are related to the fault system and fracture zone. Lead and zinc deposits occur in vein, dissemination, lens and network shapes.

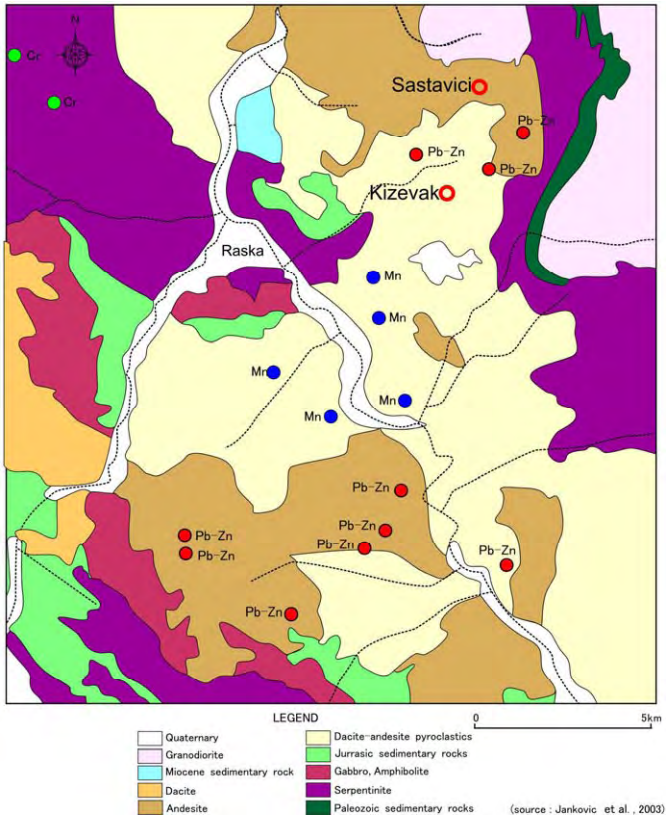


Fig.7.7 Distribution of ore drposits in the Raska Metallogenic Zone

At one time, the Suva Ruda mine produced iron and copper ores from iron-copper skarn deposits. The mine included the Suva Ruda and Suvo Rudiste deposits in the Kopaonik region. The skarn deposits were composed of garnet, magnetite, and chalcopyrite which formed in lenses of magnesite and carbonate rocks intruded by the Kopaonik granodiorite. From 1970 to 1984, 1.5 to 2.2 million tonnes of 4 to 6% copper ore were produced. After that, the Suva Ruda mine produced lead and zinc ore in the Kizevak and Sastavci deposits from 1984 to 2002 (Fig.7.7).

(a) Kizevak Deposit

The Kizevak deposit formed in dacitic to andesitc volcanic rocks, and is controlled by faults running NE-SW and E-W. Orebodies occur in irregular or extended lens shapes. The vertical extension of orebodies is 200m or more, and it has a NNE-SSW orientation with a dip of 60° to 70° to the east. Orebodies are 300m long, and vary in width from 1m to 50m.

The average ore grade is 4% Pb+ Zn. Main ore minerals are pyrite, arsenopyrite, sphalerite and galena with secondary minerals of stibnite, chalcopyrite and marcasite. Andesite around the deposit has been intensively altered by argillization, kaolinitization, silicification, pyritization and chloritization.

(b) Sastavci Deposit

Like the Kizevak deposit, the Sastavci deposit also formed in dacitic to andesitic volcanics, and is controlled by the fault system trending NE-SW. Ore minerals are chiefly arsenopyrite, pyrite, sphalerite and galena. The Sastavci deposit contains more arsenopyrite than the Kizevak deposit.

(2) Prospecting

(a) Kizevak

1) Kizevak No.1 Ore Zone

Prospecting over a total length of 5,000m was implemented by surface drilling, and underground tunnels having a total length of 7,000m were excavated. The longest drift is the No. 9 drift which strikes NNE-SSW and is 1,400m in length. There are 17 crosscuts 30m long running east to west.

2) Intermediate Zone

At the intermediate zone between the Kizevak and Sastavci deposits, 7 or 8 drift prospecting sites of 25m to 30m long were established in 25m to 30m intervals from west to east.

(b) Sastavci

Details of prospects are not clear or disclosed.

(3) Reserves

From 1984 to 1997, the mine produced 1.7 million tonnes of crude ore from the No.2 ore zone of the Kizevak deposit, and 40,000 tonnes from the Sastavci deposit, for a total of 1.7 million tonnes of ore containing 1.77% Pb and 3.3% Zn.

Since 1988, no report on geological exploration has been made. The ore reserve numbers

in Table 7.3 are based on interviews with mine staff. Ore in the No. 1 ore zone of the Kizevak deposit has not been mined, and amounts to 2.0 million tonnes with 2.16% Pb and 3.9% Zn. On the other hand, the No. 2 ore zone of the Kizevak deposit has been mined out.

Table 7.3 Reserves of the Suva Ruda Mine (as of 1988)

Ore deposit	Ore body	Reserves Kt	Pb %	Zn %	Ag g/t
Sastavci		340	2.07	5.56	45
Kizevak	No.1 ore zone	1,646	2.19	3.67	33
	Intermediate zone	340	2.03	4.87	328
	Total	1,986	2.16	3.88	84

(4) Issues

Tunnel prospecting of 7,000m total length and drilling of 35,000m was implemented at the No. 1 ore zone of the Kizevak deposit in 1980'. However, there is still a chance to extract the 2 million tonnes of crude ore that still lies buried, because the mine was under the Trepca in 1996 and it was separated from the Trepca in 2001, the mine loss an opportunity to exploit the No. 1 ore zone of the Kizevak deposit. At the present, it is needed to strip one million cubic meters of an overburdened soil for developing the No. 1 ore zone of the Kizevak deposit, and it is not a situation in which crude ore is put out at once.

However, due to the high arsenic content (4.3% As of average grade in the Sastavci deposit), it caused trouble for mineral processing that zinc concentrate contained 18% As, and only 44,000 tonnes were treated in 1984, the first year of development.

Therefore, approximately 340,000 tonnes of crude ore have not been developed. According to the manager of the mine, the gold grade in the Sastavic deposit is higher than in the Kizevak deposit, with an average grade of Au 6.6 g/t.

(5) Mineral Potential and Measure

According to the information presented above, there may be a high-sulfide type gold deposit predominant in arsenopyrite in the deep part of the deposit. Therefore, it will be necessary to consider gold assay distribution, gold occurrence, and the relationship between gold and arsenopyrite. Specifically, it is advisable to investigate three-dimensional assay distribution and zonal distribution of alteration in the Sastavci deposit, especially the kaolinite and alunite alteration and the existence of porous silicified rocks. It is also desirable to confirm the mineralization down to 300 meters under the surface in the central zone of the gold mineralization by drilling prospecting. It is difficult for mines to conduct such mineral deposit studies due to the lack of staff and capacity. It is thus advisable for these studies to be implemented by a governmental institute, such as the Geological Institute.

The Suva Ruda mine, which is bankrupt and reconstructed, is lacking funds for conducting exploration work and basic investigations of the mineralization of ore deposits. It would be desirable for state institutes to establish a supporting system to assist in the operation and reconstruction of

mines.

7.3 Mining and Processing

7.3.1 Grot Mine

(1) Overview

The head office of the mine is located in Vranje City (population: approximately 80,000), Pcinja District, about 350 km from Belgrade and about 40 km from the border with Macedonia. There are many factories producing textiles, furniture, tobacco, etc. in Vranje City, which has a bustling economy. The Grot Mine is located in Kriva Feja Village (population: 1,500) which is 30 km from the city and about 750 m higher in elevation.

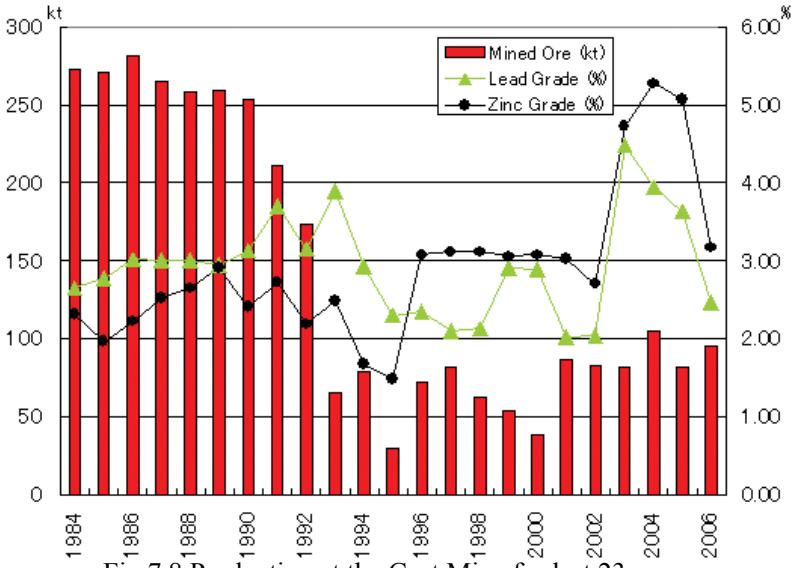


Fig.7.8 Production at the Grot Mine for last 23 years

This mine was developed by the Trepca Lead Zinc Mining Complex in Kosovo in 1974, and all concentrates were treated in the Trepca Smelter. However, the mine became independent from Trepca in 1987 due to delayed payment for concentrates. In 1995, the Trepca Complex could not attain concentrate due to the Kosovo conflict, so the government ordered the mine to join to Trepca again to provide concentrates. And finally it became independent from Trepca in 2001. Fig.7.8 shows production at the mine for last 23 years, and all production data is listed in the Appendix.

The mine increased production after opening, and had maintained more than 250,000t annual production since 1977. However, mine production dropped due to political confusion, such as the declared independence of four countries from Yugoslavia in 1991, and production was also impacted by economic sanctions imposed by the United Nations in 1993, and dropped to less than 30,000t/year in 1995. After the United Nations lifted the sanctions in 1995, production increased gradually, but production dropped again due to a second round of economic sanctions due to the Kosovo conflict in 1998. Production had dropped to 28,000t in 2000. But the mine has made successful efforts to steadily increase production.

The company fell into bankruptcy due to its accumulated debt on November 25, 2005, and is currently operating under the authority of the Agency for Privatization. A legal assignee was appointed president of the company by the agency. The total amount claimed by creditors is 15,780 million Dinars, including 7,004 million Dinars of interest. Current credit authorized by the court is 675 million Dinars, including 415 million Dinars of interest. Unpaid creditors have issued a statement of disagreement and begun the procedure for a new judgment.

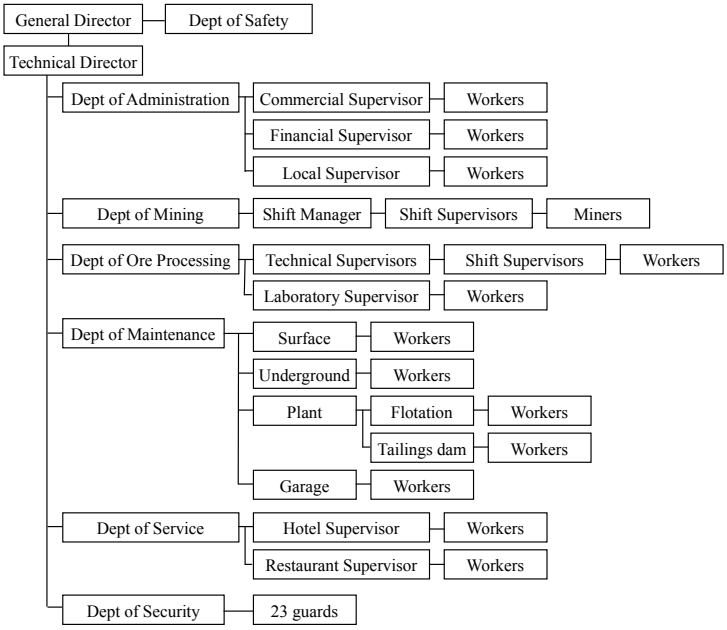


Fig.7.9 Organization Chart of the Grot Mine

In comparison with former production, current level is less than half, but the mine was operating in the black owing to high metal price, with profits of 60 million Dinars in 2005, and in 2006, it produced 2,000 t of lead concentrate and 3,900 t of zinc concentrate.

All concentrates are sold to Trafigura Ltd. of Switzerland, which had been sending them to the Plovdiv Smelter in Bulgaria. But the Plovdiv Smelter did not pay the concentrate charge last year, but the mine did not incur any damages from this, because the charge was covered by insurance.

The company organization consists of the departments of Administration, Mining, Ore Processing, and Maintenance, shown in Fig. 7.9. There are currently about 280 workers. The average monthly wages are currently 450 euros for underground miners and 320 euros for ore processing workers. These figures are much higher than the 200 to 250 euros average monthly wages in Vranje City. The educational backgrounds of workers consists of 8 university graduates, 6 college graduates, 40 high school graduates, and other graduates from junior high schools and elementary schools. The average monthly salary is 200 euros for high school graduates, 400 euros for 2-year college graduates, and 500 euros for 4-year university graduates.

The mine operates every day of the year, except Jan.1, and the working system is 2 shifts with four groups. Each shift works 12 hours and takes one day off every 2 days, and generally the workers can take 15 days off. It used to be 8 hours/shift with 3 shifts per day, 20 days (160 hours) per month, but it was changed to 12 hours per day, 15 days (180 hours) per month in 2003. Therefore, total working hours have increased by 12.5%, but workers can take half of each month off. As a result, efficiency has increased under this new system, and no worker complains about it owing to the increased number of days off.

(2) Mining

There are 4 mining areas in Grot Mine; the Blagodat, the Djavolja Vodenica, the Djavolja Vodenica 2, and the Vuckovo mining areas from the west (see horizontal location in Fig.7.2). There are 9 horizontal levels from 1,713m above sea level (Level 1) to 1,296m above sea level (Level 9). Schematic section shows in Fig. 7.10.

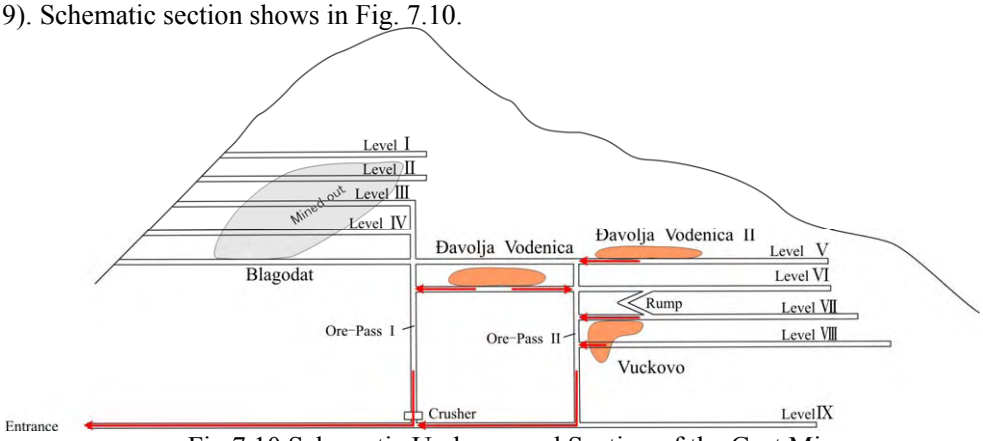


Fig.7.10 Schematic Underground Section of the Grot Mine

Characteristics of each mining area are as follows;

a. The Blagodat mining area

(dimensions: 400mW×600mL×178mH, average production grade: Pb＋Zn6％)

This is the largest ore deposit in Grot Mine, but this area is already mined-out, except pillars, in 1994. The total mined ore was about 4 million tons. The pillars are to be mined in the future. The following 6 horizontal levels are in this area.

Level 1 (1713m), Level 2 (1662m), Level 3 (1621m), Level 4 (1585m), Level 5 (1535m) and Level 9 (1296m).

b. The Djavolja Vodenica and Djavolja Vodenica 2 mining areas

(total dimensions: 300mW×1,300mL×135mH, average production grade: 8％. production weight: 50% from both mining areas)

There are 3 veins with a strike of NW and dip 0f 45°. The following 5 horizontal levels are in these areas.

Level 5, Level 6 (1490m), Level 7 (1445m), Level 8 (1440m) and Level 9

c. The Vuckovo mining area

(dimensions: 15W×250mL×135mH, average production grade: 10％, production weight: 50% with 5 stopes)

The 5 horizontal levels here are the same as in b.

Currently production is carried out in the Djavolja Vodenica, Djavolja Vodenica 2, and Vuckovo areas. All ore is dropped through ore chutes 1 and 2, and extracted at the haulage level (Level 9) to be transported to the processing plant. Ore from ore chute 1 is crushed by a primary crusher located at 15.37m above the Level 9 in underground, but ore from ore chute 2 is crushed in a processing plant. Ore flow is indicated by red arrows in Fig.7.10. The haulage distance is about 6 km

between ore chute 1 and the processing plant, about 1km between ore chutes 1 and 2, and about 1km between ore chute 2 and the Vuckovo mining area.

Ore deposits in the Djavolja Vodenica and Djavolja Vodenica 2 mining areas are very small. There are 10 stopes in the Djavolja Vodenica area with ore deposit heights of 0.5 to 3.0 m, and 2 stopes in the Djavolja Vodenica 2 mining area with ore deposit heights of about 2m. Therefore, mining can be mostly finished in these stopes by driving LHD drifts. The stopes of the Vuckovo mining area are comparatively larger. There are 4 stopes, but these stopes are in the same ore deposits. The current proven ore reserve is extremely small, so a great deal of effort is required to produce exploitable ore. It is unreasonable to expect a return to pre-1990 production levels. If proven ore reserves are not increased through urgent exploration, it might be difficult to maintain the current production level into the near future.

Mining is done in combined shrinkage and room & pillars methods. One stope section in the Vuckovo area is shown in Fig.7.11.

This mining plan was prepared by the Mining Institute. This figure shows a not so large ore body that is divided vertically in 10 m intervals by driving undercutting drifts to make stopes, which are mined from top down towards the mining zone. When a stope progresses upwards, it may be mechanically unstable under the thin ore to be mined. When it connects with the mined zone above it, a large space with a height of 20m will appear. Therefore, this method is not good from viewpoint of safety. However, increased stopes are needed to maintain production, so this method was adopted

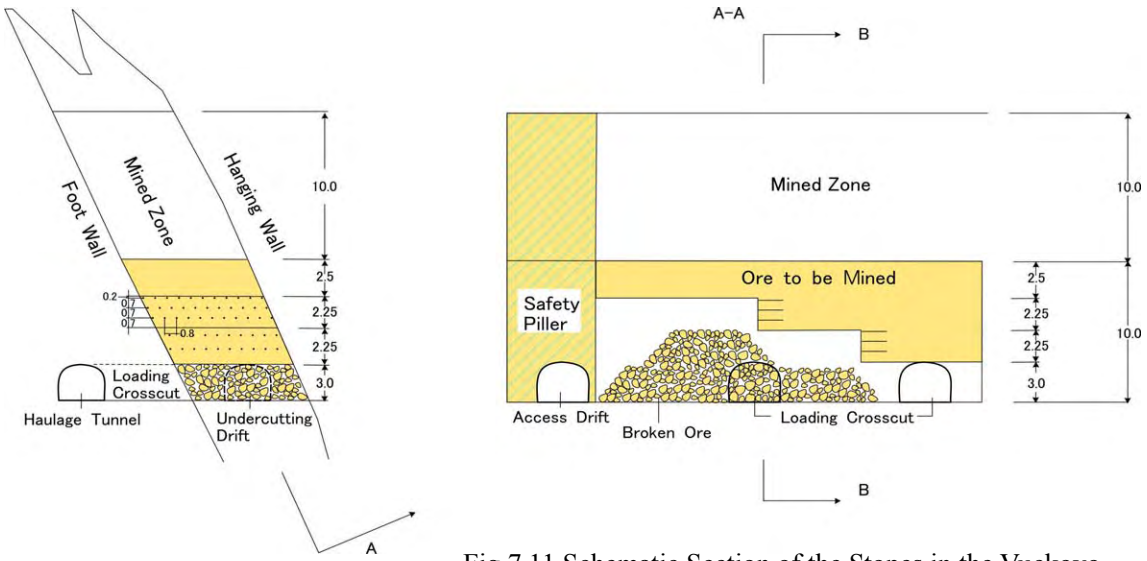


Fig.7.11 Schematic Section of the Stopes in the Vuckovo

Transporting machines consist of 2 LHDs (ST2D and ST710), and 2 underground trucks (MT431 and MT46). Ore is transported by 10t trolley locomotives with 10 mine cars each carrying $3m^3$ (6t). Blast holes are drilled by 14 jackhammers, but there is no jumbo for drilling.

Principal mining machines are listed in Table 7.4.

Table 7.4 Main Mining Machines in the Grot Mine

Type	Model	Manufacturer	Amount	Year Purchased	Notes
Compressor	ER-9	Russian	1	1980	93m^3/min
	VP-50.8	Russian	1	1967	50m^3/min
	MH-200-1S	Ingersoll Rand	1	2004	32m^3/min
	GA	Ingersoll Rand	1	2004	11m^3/min
	UP5-15/7.5	Ingersoll Rand	2	2004	2.4m^3/min
Cage hoist		GHH	1	1969	
Pump	VPD100-8	Serbian	1	1989	7.4l/s
	VP50-9	Serbian	1	2003	30l/s
Ventilator	VOK1.5	Russian	1	1975	47m^3/min
Crusher	SM16D	Russian	1	1969	200t/h
Locomotive	KR-21	Russian	3	1970	
Mine car	Okej	Serbian	10	2007	3.5m^3
	Okej	Serbian	10	1992	3.5m^3
Leg-hammer	MFD90LC	Slovene	2	2004	
	BBD95	Atlas Copco	2	1998	
	VK-30	Slovene	2	1980	
LHD	ST-710	Atlas Copco	1	2004	3.1m^3
	ST-2D	Atlas Copco	1	1996	1.9m^3
Dump Truck	MT-413	Atlas Copco	1	1996	6.0m^3
	MT-416	Atlas Copco	1	2003	8.0m^3
Drill	Meter	Longyear	1	2005	170m
	Tampella	Tamrock	1	1985	50m

Broken ore is loaded by LHD into the underground trucks, which transport the ore to the ore pass. A crusher is installed at the bottom of the ore pass and above the haulage level. Crushed ore is loaded into mine cars and transported 7 km by the 10t trolley locomotive to the ore processing plant on the surface. Currently the mine produces 500 tons /shift with 8 to 9 trains per shift.

The mine has some spare parts for diesel engine machines, but when there is a shortage, the branch office in Belgrade must order them. It takes about one month to receive them. Accordingly, some machines are sometimes idle for a month due to a shortage of spare parts.

Machine inspection is carried out for every shift, taking 2 hours before operation, and a maintenance log is kept. Overhaul of principal machines such as LHDs, dump trucks, and trolleys is done in the underground workshop once every 5,000 operating hours, and diesel engines are also overhauled in the repair shops in Beograd once every 5,000 operation hours.

There are many old machines that were bought in 1960s to 1980s (Table 7.4).

Ventilation is important for underground operation, because many diesel engines have been used since a trackless mining system was introduced. Blind drifts are ventilated by local fans and air ducts. There are two types of air ducts, as follows;

For 400mm in diameter, the maximum length of blind drift is 100m.

For 600 mm in diameter, the maximum length of blind drift is 250m.

For more than 250m of blind drift, ventilation raises are driven every 200m.

Drift dimensions are 3.5m (W)×3.0m (H), so LHDs with dimensions 2.4m (W)×2.2m (H) can pass through drifts with air ducts. The maximum gradient of LHD ramps is 17/1,000 (17%), which is almost the same as in Japan. It should be noted that underground dump trucks are only used

in large stopes, and not in ordinary drifts.

Medium/long term production plans have not been prepared, because the company went bankrupt without future perspective.

Safety results are listed in Table 7.5. Comparing the last 5 years with 1991, the total number of accidents has decreased. The mine managers attribute this change to decreased operation strength resulting from the introduction of large machines, such as LHDs.

Table 7.5 Safety Results

Accident	2002	2003	2004	2005	2006	1991
Light	9	6	7	1	5	30
Heavy	2	4	3	3	2	3
Fatal	0	0	0	1	0	0
Total	11	10	10	5	7	33

Compared to western mines, awareness of safety is not likely to be higher, because the underground is dark and drifts are not neat. In the stopes, there are no barricades to prevent falls. Miners wear helmets, but do not wear dust masks or safety glasses.

In addition to the 4 current mining areas mentioned above, there is the Kula area, which is 1300m W × 1500m L × 150m H. Its average production grade is estimated to be 7%. Exploration in this area was carried out from 1984 to 1992. A new entrance in another mountain, 12 km from the current entrance, was begun in April 2007. 500m drift is necessary to reach to this ore body. Production will start 3 to 5 years from now, and ore will be transported by trucks to the processing plant. There is another access plan, which connects underground from Djavolja Vodenica 2.

In the Karamanica mining concession (copper, lead, and zinc) which is located comparatively close to the Grot Mine, about 3km drifts in total were driven by Russians in three levels to produce about 150,000t ore from 1965 to 1970. Ore produced here is very high grade (more than 20% in total).

Another company applied for an exploration license for the Karamanica concession and was granted a license for about 10% of the total concession area. However, the Grot Mine objected to this license because the mine is located near the concession and they have been collecting concession information for a long time. So, exploration activities in the concession are currently suspended, pending a judgment by the MEM. According to the judge, the Grot Mine will need to apply for exploration and exploitation licenses.

(3) Mining Operations

In the Djavolja Vodenica and Djavolja Vodenica 2 mining areas, production crews consist of 1 foreman, 1 crew leader, 8 drill men, 8 assistant drill men, 2 LHD operators, 2 dump truck operators, and 1 blasting man. In the Buckovo mining area, production crews consist of 1 foreman, 1 crew leader, 2 drill men, 2 assistant drill men, 1 LHD operator, and 1 blasting man. Further, non-production crews consist of 2 boring men, 2 electricians, 4 mechanics, 1 compressor operator, 1 cage operator, 1 ore chute keeper, 1 underground crusher operator, 2 locomotive operators for ore

transportation, and 1 locomotive operator for miner transportation. 1 group is made up of 46 workers. There are four groups (184 workers in total), which work in two 12-hour shifts. This number of underground workers is very large, but the mine staff explained to the study team that the number of underground miners has decreased since a trackless mining system was introduced in 2000 and the annual production has also decreased from 260,000 tons to 130,000 tons.

Mining operation efficiency was analyzed based on the work of 184 workers. The total working days are 364, miners work every 2 days, and miners take an estimated 20 days of vacation per year. So, the total man-days per year are calculated to be 29,808. Each worker works 12 hours a day, which means 1.5 man-days with a base of 8 hours per day. But they take one day off every 2 days, so 12 hours per day is considered one man-day in the case of this mine. For example, production was 94,938t in 2006, so the total underground efficiency is calculated to be 3.2 t/worker, which is amazingly low. When this is compared with a Japanese underground mine, it is less than half the 6.71 t/worker of the Tochibora Mine, Kamioka in 1965 before introduction of a trackless mining system. It should be noted that this Japanese mine made efforts to mechanize by adding a trackless mining system, and its total efficiency increased to 51.33 t/miner.

The main reason for the low efficiency at Grot Mine is excess workers, due to the 4-group 2-shift system. The work schedule for drill men was investigated through interviews; and the results are as Table 7.6. The transportation time here is notably large, and net underground work time is 6 hours, which is almost the same as other mines with a normal 8-hour shift. Therefore, unless efforts to decrease transportation time are taken, operation efficiency might remain low and mining costs might remain high.

Table 7.6 Work Schedule for First Shift Drill Men

Time	Job description
6:00–7:00	Commuting by bus from Vranje to Kriva Feja
7:00–8:00	Change clothes and take locomotive from entrance to underground
8:00–9:00	Walk from underground station to stope
9:00–10:00	Inspect stopes and scale
10:00–16:00	Drill blasting holes (in 2 stopes)
16:00–17:00	Load explosives and prepare blasting
17:00–17:15	Conduct blasting
17:15–18:00	Walk to underground station
18:00–19:00	Take locomotive from underground to surface and change clothes
19:00–20:00	Commuting by bus from Kriva Feja to Vranje

The low efficiency of the Grot Mine is also due to low mechanization and the small capacities of the stope transportation machines. However, the introduction of large machines is not appropriate for the small dimension of stopes under operation, because of excess ore dilution. Therefore, improvements to stope transportation have limitations. It is possible to enlarge mine cars, but major effects of investment cannot be expected with the current inexpensive labor costs.

There is a lack of operation efficiency data. For example, precise production amounts for each stope are not measured. Only total production is weighed at the processing plant. So, mining

efficiency for each stope is unknown. Also, there is no precise data for drifting lengths, drilling lengths, and waste amounts, which are all basic factors for operation management. Under these conditions, it is nearly impossible to think of good ideas for improving efficiency.

Increased operation efficiency might be expected with increased air pressure and water pressure .

Regarding safety, ceiling fall may be the most important matter from viewpoint of the room & pillars method with large open spaces. If open space is regulated, cut and fill methods should be introduced without sublevel undercutting. However, it is impossible to make plural stopes in one ore body, so there may be some limitations to production.

(4) Mining Costs

Detailed information on mining costs could not be acquired, except for the principal mining material consumption for 2006 listed in Table 7.7.

In the case of Japanese mines, each cost is shown as a percentage of the total mining cost as follows; principal mining materials 20%, labor 35%, repair of mining machines 15%, underground maintenance 7%, subcontractors 15%, and other costs 8%. Labor costs higher in Japan, but the cost of mining machine repairs is reportedly higher in Serbia.

Table 7.7 Consumption of Principal Materials in the Grot Mine (2006)

Material	Unit	consumption	Mined ore	Unit consumption	Unit price (din.)	Amount (din.)
Explosives	Kg	64,876	123,066	0.527	99.12	6,430,509
Detonator	Pcs.	109,112	123,066	0.887	56.64	6,180,104
Drill rods	Pcs.	435	123,066	0.003	4752.00	2,067,120
Blasting cables	M	15,800	123,066	0.13	7.80	123,240
Fuel	L	133,507	125,822	1.06	72.22	9,641,875
Water tubes	M	1,200	123,066	0.009	141.60	169,920
Air tubes	M	1,200	123,066	0.009	141.60	169,920
Diesel oil	L	22,951	125,822	0.182	213.60	4,902,334
Tyre	Pcs.	51	125,822	0.0004	68,546.40	3,495,866
Tube	Pcs.	55	125,822	0.0004	2,194.80	120,714
Belts for tyre	Pcs.	50	125,822	0.0004	1,699.20	84,960
Hydraulic oil	L	1,979	123,066	0.016	212.40	420,340
Electric power	Mwh	2690	117,665	22.86	3120	8,391,646
Bearing (mine car)	Pcs.	169	117,665	0.0014	1,387.44	231,702
Diamond bits	Pcs.	27	955	0.028	13,600.00	367,200

The underground wage is determined by norm per shift. Each shift operation is measured by a foreman who creates all the daily operation reports. Table 7.8 shows partial operation norms.

Table 7.8 Operation Norms for Grot Mine

Work	Operation	Norm
Drifting (size: 3.5m × 3.0m)	Horizontal drifting	1.6m/worker
	Inclined drifting	1.5m/worker
	Mining	75t/worker
	Raising	1.5m/worker
Loading & transportation (Djavolja Vodenica)	LHD, dump truck	180t/worker

Loading & transportation (Vuckovo)	LHD, dump truck	160t/worker
Crushing & ore transportation	At IX Level	180t/worker
Manual loading	Non-mechanic	6t/worker
Drilling	Less than 30m	3.0m/worker
	More than 30m	2.0m/worker

Generally speaking, these figures are considerably lower than Japanese average efficiency. This is due to delayed mechanization.

There is detailed expenditure data in the head office of Grot Mine (Table 7.9). However, this is for the total of all departments, including mining, processing, mechanical repairs, administration, etc. There is no data for only mining. So, the calculated and compiled data is not used for cost management. Expenditure items for mining are material costs, labor costs, repair costs, maintenance costs, subcontractor costs, and electricity costs. By checking variations in these figures over time, mining cost management is possible.

Cost savings in the mine should be implemented as a basic step. For example, limiting the needless running of heavy machines, increasing the ratio of AN-FO, preventing air leakage, and decreasing water lifting through dewatering holes, should be noted, in consideration of the comparatively large amounts of principal materials listed in Table 7.7.

Table 7.9 Cost Management Data at Grot Mine

РАСХОДИ	Јул	Август	Септембар	Октобар	Новембар
5110 Утрошни основни материјал и сировине	1,858,569	0	1,834,599	2,318,975	4,127,162
5113 Укалкулисани кало, растур, квар и лом	16,380	0	35,546	4,108	4,690
5114 Утрошен остали материјал за израду	1,732,007	0	1,934,623	1,569,185	543,498
5115 Утрошен остали материјал за израду	22,637	0	1,152,558	1,899,597	355,482
5116 Утрошен остали материјал за израду	54,113	0	172,642	55,588	163,937
5118 Гориво и мазиво	744,494	0	2,597,522	1,605,767	1,020,758
5120 Утрошен материјал за текуће и инвестиционо одр	5,339	291,780	31,420	0	0
5128 Утрошен остали материјал режијски	4,201	3,791	62,880	11,998	3,516
5130 Горива и мазива	75,800	0	72,800	56,090	3,500
5133 Утрошена електрична енергија	1,550,804	0	1,430,741	12,678	3,076,969
5200 Трошкови бруто зарада	12,251,616	9,159,635	9,914,965	11,920,356	11,400,000
5310 Трошкови превоза	77,429	60,700	76,508	155,140	140,653
5313 Трошкови за услуге регистрованих носача	20,413	509	27,076	43,438	0
5315 Трошкови ПТТ услуга	22,060	6,720	6,250	5,050	0
5319 Остале транспортне услуге	2,174,859	855,791	532,037	0	0
5320 Трошкови на текућем одржавању основних сред	1,401,329	0	198,660	5,220	0
5339 Трошкови закупнина	0	20,000	0	20,000	21,550
5359 Остали порези који терете трошкове	0	2,083	0	0	4,200
5360 Доприноси на терет стечајног дужника	670,650	0	958,938	0	0
5369 Доприноси за социјално	488,045	0	0	0	280,000
5392 Таксе административне, судске	9,762	0	0	9,203	0
5399 Остали нематеријални трошкови	2,000	0	0	0	0
5503 Трошкови здравствених услуга	21,789	2,181	11,405	40,934	0
5509 Остале непроизводне услуге	4,756	15,860	50,895	28,315	27,845
5510 Трошкови репрезентације у сопственим простор	183,871	0	273,681	301,581	155,004
5512 Трошкови угоститељских услуга	15,761	0	0	0	6,780
5520 Премија осигурања	0	0	1,158,195	50,163	0
5530 Трошкови платног промета	230,904	15,361	14,472	42,410	18,547
5539 Остали трошкови платног промета	615,123	633,677	24,750	78,328	0
5550 Порез на имовину	0	0	0	141,486	0
5552 Накнада за коришћење вода	3,967	0	4,769	4,628	0
5559 Остали нематеријални трошкови	456,782	0	0	0	0
5591 Таксе судске, регистрационе и остале	0	2,810	2,810	41,340	20,541
5599 Остали нематеријални трошкови	0	0	154,314	1,107	3,710
5626 Затезне камате	25,120	1,086,515	0	30	0
УКУПНО РАСХОДИ	24.710.578	12.157.412	22.755.056	20.422.714	21.378.346

7.3.2 Lece Mine

(1) Overview

The company is headquartered in Medvedja City (population: about 10,000), Medveda District, approximately 320 km from Belgrade. The mine is located in Lece Village (population: about 3,500).

The mine dates back to 1934 when an English company started mining activities in this area. It was inactive during World War 2, but the government reactivated it in 1945. The mine was joined with the Trepca Group in the 1970s, but it later became independent. Then in 1991, it was rejoined with the Trepca Group. The mine stopped operations in 2001 due to the economic sanctions, and simultaneously became independent from the Trepca.

According to the data, in 1985, the ore reserve was 2 million tons (1.64%Pb, 3.16%Zn, 2.96g/tAu and 23g/tAg). The main ore body, Jezerina1, is 30% mined, and 70% unmined. There are 2 other ore bodies besides the main ore body.

The company consisted of an Administration Dept. (accounting, regulation and marketing), Production Dept. (underground mining and flotation) and Maintenance Dept., and there was a total of 230 mine workers (110 for underground mining, 80 for ore processing and 40 for other work). Current workers are 27 (25 workers contracted for security and lifting water from the underground, 1 engineer and 1 driver).

During normal times, operations were carried out in 3 shifts per day, with 2 weeks down time per year for maintenance. The actual time spent working in the underground was 6 hours per shift.

The Mining Institute conducted a survey for reopening the mine in 2001 to 2002 and estimated that it would take an investment of 1 million euros to reopen the mine. Purchasing machines for mining and ore processing account for most of the cost.

The mine has continued lifting water from the underground since stopping operation in 2001. Abandoned machines on the surface are too damaged to use again.

(2) Mining

There are two ore bodies; the Jezerina Orebody with 4 horizontal levels at vertical intervals of 50 meters, and the Rasovaca Orebody with 5 horizontal levels at vertical intervals of 35 to 70 meters.

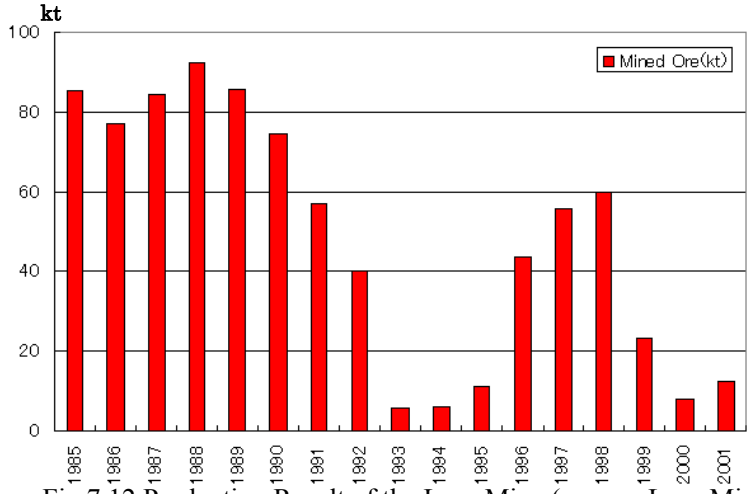


Fig.7.12 Production Result of the Lece Mine (source: Lece Mine)

The main mining method was the Shrinkage Method at the beginning stage, but afterwards it was changed to the Sublevel Stoping Method. The mother rock is rigid with an excavation support ratio of only 10 % in the main levels. The main mining machines were leg hammers for drilling, 5 air loaders and 3 HSTs for loading.

Production of the mine was normal from 1957 to 1977. Annual production was kept at more than 80,000 tons with grades of Pb1.7%, Zn3.9%, Au4.2g/t and Ag16.5g/t. The high grades of gold and silver are particularly notable. Fig.7.12 shows production results from 1985 to 2001. Production peaked at 90,000 t/year in 1988, but by 1993 had fallen to a mere 6,000 t/year due to the economic sanctions imposed by the United Nations. After 1996, annual production had recovered to the 40,000 to 60,000 t level, but it dropped again in 1999 due to a second series of economic sanctions. Owing to a shortage of mining machines, production was stopped in 2002. All operational results are listed in the Appendix I-5-3.


Transportation System for Crushed Ore

(3) Ore Processing

Ore mined in the underground was sent to the crushers, and then transported by ropeway to the ore processing plant located in another mountain. The reason for constructing the plant in another mountain was that there was insufficient space for the plant and tailings pond in Lece Village.

Concentrate grades were 60%Pb in lead concentrate with 100g/t Au and 450g/t Ag, and 51% in zinc concentrate with 4.5 to 7.0g/t Au. All concentrates were processed in Kosovo at the Zvecan Smelter belonging to the Trepca Group.

Exceedingly large machines were installed in the ore processing plant in comparison with production result of 250 t/day.

Tailings have been deposited in a total of nine ponds. As mentioned above, crude ore had higher grades of gold and silver. The Mining Institute in Belgrade investigated the gold grade in the tailings by 4 drilling holes in the ponds. The results showed a grade of 1.1g/t Au and the volume of tailings was calculated to be 1.5 million tons. However, the actual tailings volume may be larger than this, because total production was 3 million tons.

The annual mining capacity was 110,000 tons at maximum, and the annual processing capacity was 220,000 tons. Therefore, the mine might have the capacity to both process mined ore, and re-process the tailings.

Ivanhoe Mines Ltd. has conducted some exploration around the mine, but has not indicated any interest in purchasing the mine.

7.3.3 Kizevak Mine

(1) Overview

Head Office of the Suva Ruda

The Suva Ruda Mining Co. Ltd. which holds the Kizevak Mine is located in the Raska District of Raska City, about 300 km south of Belgrade. The company opened the Suva Ruda Mine and Suvo Rudiste Mine nearby Kopaonik, currently national park, in 1970. The company name came from this mine. The Suva Rudishte Mine was open pit in summer, and underground in winter. Ore was processed in the Dona Rudnica Plant. At that time, the mined minerals were magnetite and chalcopyrite. Iron concentrate was sold to Sartid Ironworks (currently US Steel) located in Smederevo, about 60km east of Belgrade, copper concentrate was sold to RTB Bor. Both mines stopped operation in 1984 due to exhausted reserves. The total amount of mined ore was less than 2 million t for 14 years, but its grade was reportedly about 5%. Detailed production data exists.

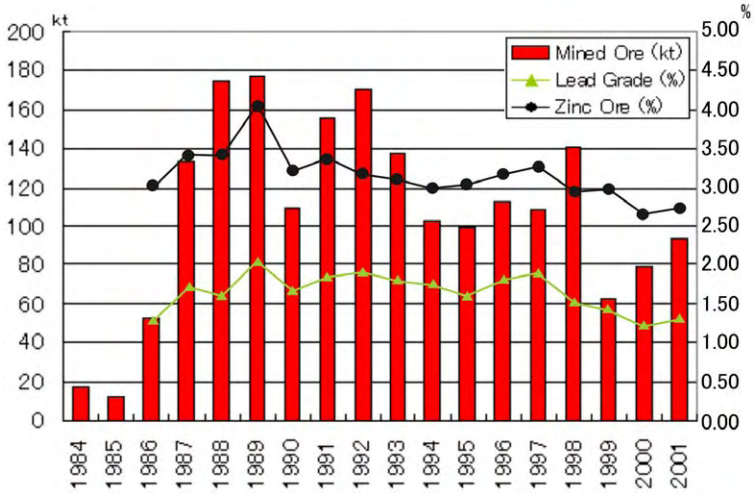


Fig.7.13 Lead and Zinc produced in the Kizevak Mine

The company opened the Kizevak and Sastavci Mines in 1984. The Sastavci Mine is 3km north-northeast from the Kizevak Mine. Mined ore was processed in the Dona Rudnica Plant, which treated copper and iron ore. The ore from the Sastavci Mine contained more than 4% arsenic in ore, and 18% in concentrate. Therefore, Sastavci ore could not be treated alone, and was always treated together with Kizevak ore. However, the Sastavci Mine could not operate very much due to arsenic problems, and operated in only 4 years; 1984, 1988, 1989 and 1990. The total production was only 44,854t. Currently, it is impossible to go to the mine site by normal cars due to very bad road conditions. Therefore, ore was mined mainly from Kizevak Mine. Fig.7.13 shows the production. Production peaked from 1988 to 1992 with 160,000 to 180,000t/year. According to production data from 1984 to 1997, the total production was 1.74 million t with an average grade of 1.77%Pb and 3.31%Zn. Production data after 1998 was the amount treated in the Trepca Smelter.

The mine became independent by 1995, and transported the concentrate to the Zorka Smelter. In 1996, the mine joined with Trepca, and transported the concentrate to Trepca. After the mine became independent from the Trepca in 2001, the concentrate was sold to the Zletovo Smelter in Macedonia.

The company went into bankruptcy in 2002, because they could not prepare ore-body No. 1 for new mining although ore body No. 2 was almost exhausted. Operation was not profitable due

to low metal prices at that time, and debt accumulated.

There were a total of 150 workers in various departments when the company operated normally, two mining engineers and one geologist were always at the mine site, and a geologist worked in the head office in Raska.

There are currently only 9 workers in the head office and 9 guards to watch the facility. Their wages are paid by the Agency for Privatization.

The procedure of privatization has progressed under the agency, and an auction was held on June 4, 2007 with an initial value of 1.2 billion Euros. There are 4 companies which are interested in the mine, 2 Canadian investors, a Russian investor, and a local investor.

(2) Mining


Current state of the No.2 Ore body

The Kizevak Mine consists of the No.1 and No.2 ore bodies and a connecting part between them. Ore-body No.2 has continually been mined in the past. Ore-body No.2 has a pit about 100m long, 60m wide, and 120m high (12 benches with 10m high). For mining operations, there were five 30t dump trucks to transport ore in the pit, four 20t dump trucks to transport waste, two wheel loaders (one for ore trucks and one for waste trucks), and also drill machine made by Atlas Copco. The stripping ratio was 1:3 during normal production. When Ore-body No.2 was almost exhausted, they worked intensively to prepare mining in Ore-body No.1, including many exploration drifts and drilling for calculation of ore reserve. However, they did not have sufficient time to strip about 1 million m^3 of waste from Ore-body No.1, and the company went into bankruptcy.


Repair shop (R) and warehouse for spare parts (L)

Mined ore was transported by 30t dump trucks to the Dona Rudnica plant, which is 12km south of the mine. A 6km road from the national road to the mine was constructed and paved by the company in 1984.

There are a repair shop, a warehouse for spare parts, an electrical receiving facility, shower for workers, a clothes-changing house, a kitchen and restaurant, a mining office, and a medical room for emergencies near the pit.

One serious problem in Kizevak was ore dilution. For example, a total of 2 million t was mined for ore of 0.96 million in the No.11 mining zone, and ore grade accordingly dropped from 7%

to 2%. It seemed to be caused by well separation between ore and waste due to the small dimensions and irregular shape of ore body.

Technical comments could not be given, because there was no detailed data, but some points could be identified as follows;

a. Failure in scheduling the production of Ore-body No. 1, in consideration of the residual amount of reserve.

   This might be solved by increasing shifts or subcontracting outsiders to strip waste from Ore-body No. 1.

b. Large ore dilution

   This might be solved by halving bench height, separating blasting for ore and waste, or blending the accumulated ore for the plant.

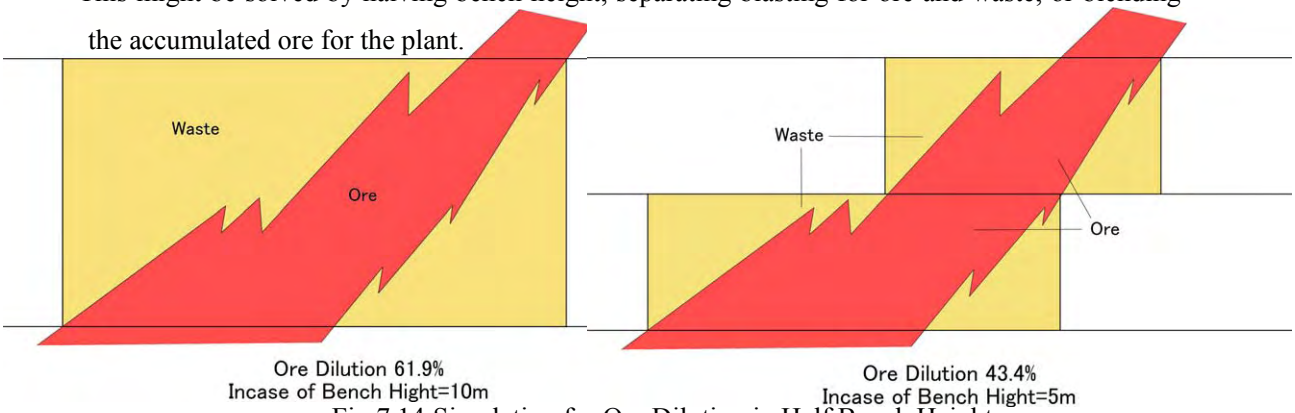


Fig.7.14 Simulation for Ore Dilution in Half Bench Height

c. Too many workers

   Were any measures taken against the very low operation efficiency?

d. Flexibility of the operation system according to the appropriate number of machines

   Were any measures taken to minimize the waiting times of wheel loaders?

There is no comment on mining costs, because no cost information was unfortunately given.

7.4 Processing Plant and Tailings Dam of the Bor Complex

7.4.1 Objectives of Study

- Collect basic data and assess current Mineral Processing and Tailings Dam Management field conditions.
- Identify problem points.
- Identify possible overlap points with current World Bank projects.
- Collect data on unutilized resources.
- Conduct case study centered on introduction of leaching technology, and interpret analysis results.

- Analyze identified problems and suggest courses of action.
- Carry out Capacity Development related to Mineral Processing and Tailings Dam Management.

7.4.2 Case Study Result

The Case Study on Mineral Processing and Tailings Dam Management was executed as follows.

a. Core drilling to collect leaching test samples at two (2) tailings dams.
b. Collected process samples from two (2) targeted operating plants to determine recommendations for appropriate operation conditions.
c. Leaching tests (laboratory tests and bench scale tests) using core samples.
d. Presented recommendations for selecting appropriate operating conditions based on analysis of samples and collected data, and reference to other processing plants.
e. Capacity Development related to Mineral Processing and Tailings Dam Management.

(1) Drilling Core Samples

(a) Old Tailings Dam at the Bor Mine

At No.1 old tailing dam, 20 m depth core-boring at 8 points, of which at 6 points along with longitudinal and at 2 points along with transverse section, were carried out. Samples of each one meter depth were mixed up as one composite sample of bore hole. Analysis was made for sample from each one meter depth.

Fig 7.1 shows points of core-boring and sampling. And photos of BB1-BB4 are scenes of core-boring and sampling.

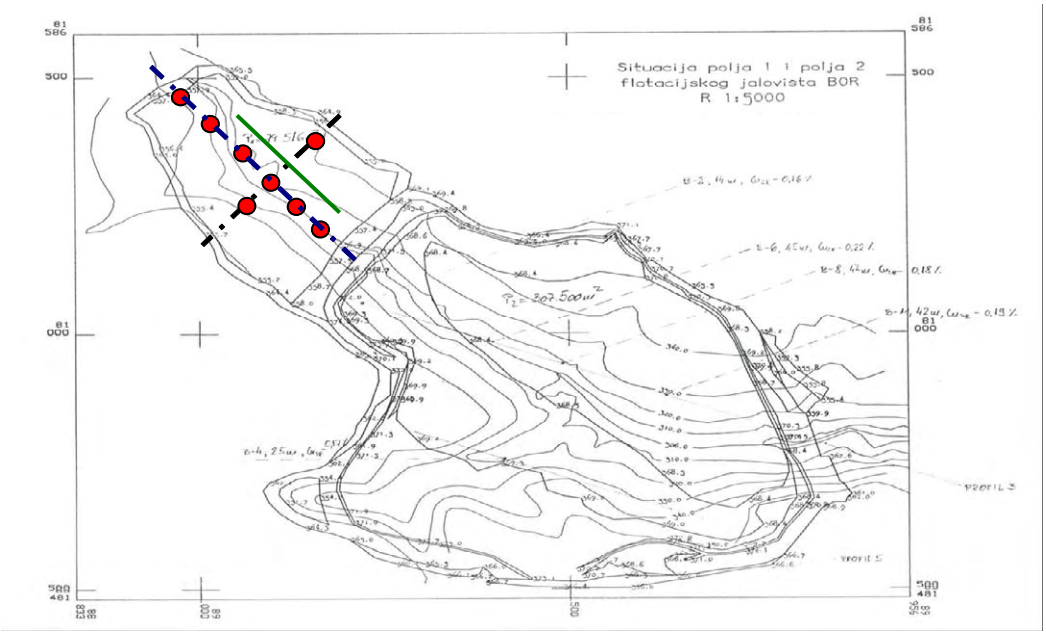


Fig.7.15 Core- Drilling Points in the Old Tailings Dam at the Bor Mine

・BB-1：No.1 Core-boring and sampling point at old tailing dam of Bor,・BB-2：Scene of core-boring and sampling point at old tailing dam of Bor,・BB-3 : Soft and slippery surface condition of old tailing dam of Bor after precipitation (stack scene of a track loaded boring machine),・Drilled core of old tailing dam of Bor (core recovery 100%)

(b) Results of Core-Drilling and Sampling

- Each 20 m depth hole did not reach to the base rock zone.
- Analysis data of each hole composite sample from B1 to B8 is shown in Table 7.10. Cu grade is between 0.25% and 0.34%, and analysis data of composite sample of all 8 holes show 0.304 % of Cu grade as shown in Table 7.12.
- During rain falling and after raining, boring works and transportation in the tailing dam were very hard with muddy condition (cf. Photo BB-3).

Table 7.11 Chemical Composition of 8 Holes Partial Composites (Drilling Core Samples)

DRILL HOLE	ELEMENTS				
	Cu (%)	S (%)	Fe (%)	As (%)	Sb (%)
B-1	0.32	10.97	8.82	0.016	<0.005
B-2	0.32	9.90	8.12	0.011	<0.005
B-3	0.34	9.37	8.72	0.016	<0.005
B-4	0.32	13.52	11.40	0.010	<0.005
B-5	0.30	13.61	10.08	0.0095	<0.005
B-6	0.26	9.43	8.21	0.0097	<0.005
B-7	0.25	13.60	7.46	0.013	<0.005
B-8	0.32	13.21	10.90	0.010	<0.005

Table7.12 Chemical Analyses Data of Composite Sample

Overall composite	ELEMENTS								
	Cu (%)	S (%)	Fe (%)	As (%)	Sb (%)	Pb (%)	Zn (%)	Ag (g/t)	Au (g/t)
40kg	0.304	11.701	9.225	0.0119	<0.0050	/	0.022	3.0	0.63

(c) Lece Mine

At Lece Mine there are 9 tailings dams numbered 1 to 9 as you progress downstream. 8 core drillings were initially planned on 3 older dams (from No.2 to No.4). However, dam No. 1 was not included because of its proximity to buildings and roads. Drilling was conducted in the same way as with the Bor old tailings dam, and was 20 m deep. Because machine access to dam

No. 2 was difficult, 5 vertical and 5 horizontal hand-auger samples were taken. 20 m deep core samples were drilled at 6 points in dam No.3. Only 20m deep core sample could be drilled in the bush at the No.4 tailings dam. Core samples were taken at every one m for each hole and were combined into 1 composite sample for each bore hole for leaching tests. Each bore hole reached base rock at around 15m, however core drilling continued to 20 m depth. The data is currently undergoing interpretation. However, we can say that despite low copper content (less than 0.1%), Au content is considerably high and in the economically viable range (in excess of 1g/t). (Drilling points are shown in Fig.7.16).

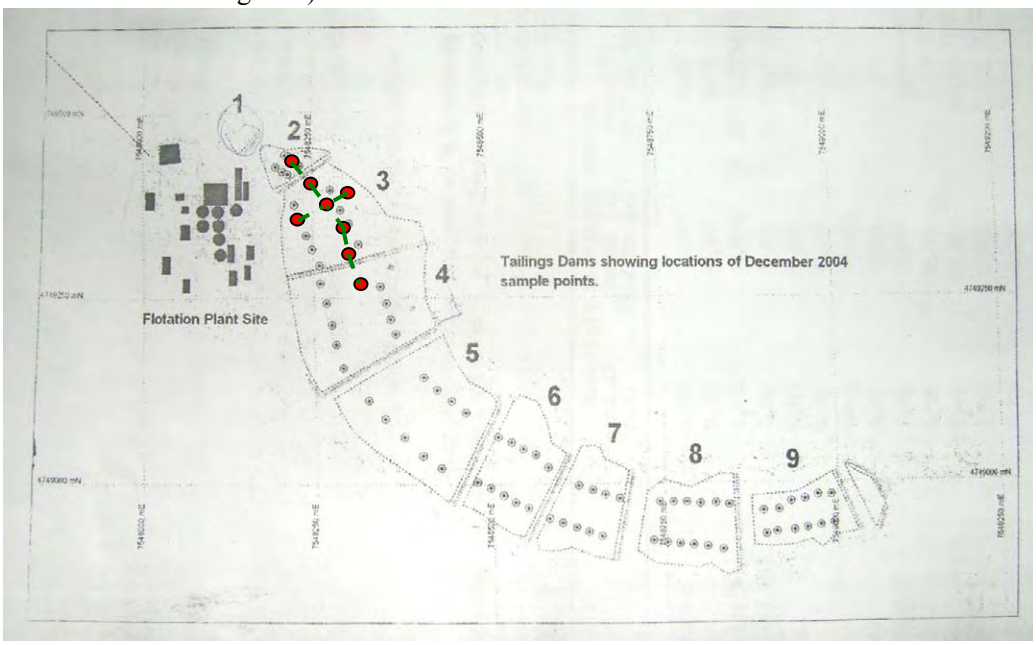
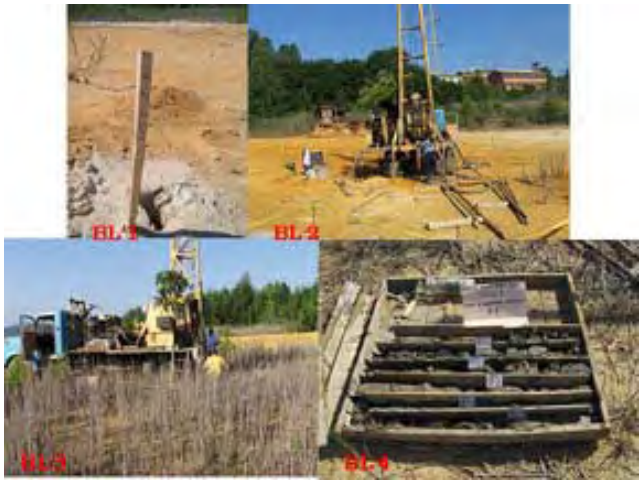


Fig.7.16 Core Drilling Points at the Lece Mine Tailings Dam



BL-1：Core-boring･sampling scene at LECE mine tailing dam, ･ BL-2：Boring･sampling scene at LECE mine tailing dam No.3, ･BL-3：Boring･sampling scene at LECE mine tailing dam No4, ･Recovered core of Lece tailing dam (around 90% recovery)

(b) Result of Core-drilling and Sampling

Each hole get to base rock at around 15m, however, core-drilling works was kept until 20 m depth. Now the data are being arranged, Cu grade may be low (<0.1%) and Au grade is high (>1g/t) in the economically extractable range according to obtained data.

Chemical analysis result of one hand auger sample (T-1) and seven drilling core samples (B-2 - B-8) are shown in Table 7.13. Grades of Pb, Zn and Cu are not high enough for exploiting economically, however, Au grades of T-1 sample is 4.0g/t, and B-2 to B-8 samples show from 1.1to 1.7g/t indicating extractable enough. The data of composite sample of all 8 holes indicate 1.33g/t Au as shown in Table 7.14.

Table7.13 Chemical Analyses Results of Drilling Core Samples

Drill hole; Pipe sampler	ELEMENTS				
	Pb (%)	Zn (%)	Cu (%)	Au (gr/t)	Ag (gr/t)
T_1 (Pipe sampler)	1.10	1.07	0.072	4.0	12.0
B-2	0.37	0.79	0.061	1.2	4.5
B-3	0.28	0.52	0.030	1.4	4.0
B-4	0.15	0.32	0.029	1.1	3.1
B-5	0.19	0.32	0.027	1.3	5.1
B-6	0.15	0.34	0.048	1.7	2.8
B-7	0.16	0.29	0.025	1.3	3.3
B-8	0.16	0.34	0.049	1.3	2.7

Table7.14 Chemical Analyses Result of Composite Sample

Overall composite	ELEMENTS							
	Pb (%)	Zn (%)	Cu (%)	As (%)	Fe (%)	S (%)	Au (g/t)	Ag (g/t)
35kg	0.21	0.42	0.038	0.049	4.15	1.09	1.33	3.64

(2) Sampling, Analysis and Interpretation of Processing Plant

1) Grot mine

(a) Sampling Points

Sampling points of Grot mine processing plant were planed five (5) as shown in Fig 7. 3. However, finally, seven (7) samples were taken adding two (2) samples considering complex of process flow. Seven sampling points are shown in Fig. 7.4 Material Flow.

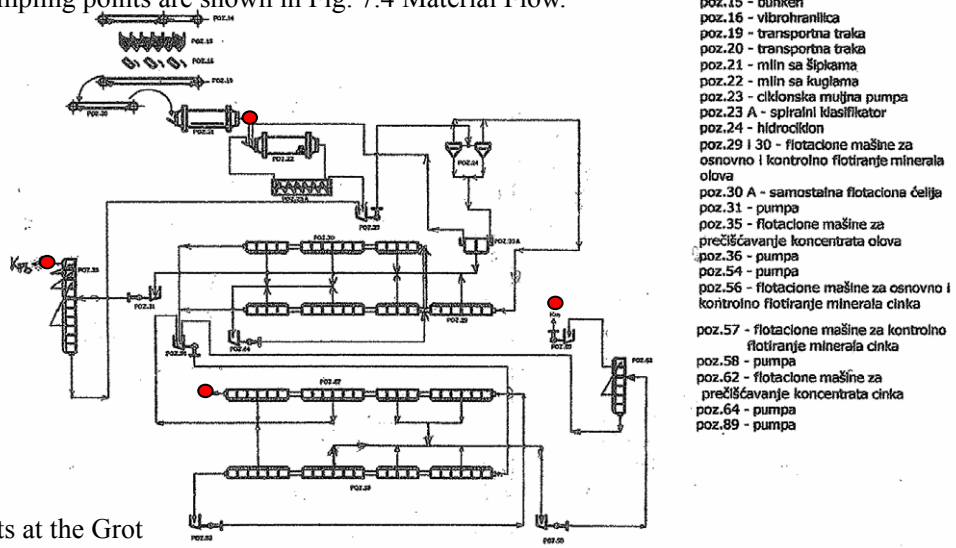


Fig.7.17 Sampling Points at the Grot Mine Processing Plant

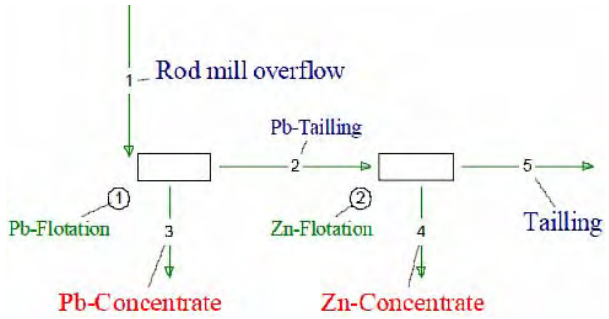


Fig7.18 Material Flow Concept for Flotation Plant of the Grot Mine

(b) Analysis Result

Comparison between chemical analyses result in this study and previous 5 years' operation results is shown in Table 7.15.

Table7.15 Analysis Results of Processing Plant

Parameter	Element	Period of sampling	Previous 5 years(*)
Elements concentration in ore	Pb, %	2,26	2,0 – 3,0
	Zn, %	2,73	3,0 – 4,0
Elements concentration in concentrate	Conc. Pb / Pb %	70,16	73,5 – 76,0
	Conc. Pb / Zn %	10,30	2,5 – 3,0
	Conc. Zn / Pb %	3,19	4,0 – 5,0
	Conc. Zn / Zn %	53,59	50,3 – 51,3
Recovery of elements in concentrate	Pb, %	83,82	84 – 86
	Zn, %	71,98	86 – 88

(*) **Previous year's data are given based on Reports received from Authorized Staffs in Mine GROT**

The analysis results are summarized as follows;

- Zn grade of feed ore shows higher than past 5 years.
- Pb-concentrate grade is 5.6 points lower than past.
- Zn-concentrate grade is 5.6 points higher than past.
- Pb recovery is a little lower than past.
- Zn recovery is lower more than 15 points than past.

Those data are analysis result of samples which were taken during less than half a day after started operation when the operation condition might be sensitive.

Furthermore, following problems can be pointed according to the team observation on the operation condition.

- Feed size for flotation is fairly coarse (80% pas size might be 150-212μm).
- Slurry density for flotation is low as 30.5% (around 40% is desirable).
- Excess consumption of industrial water in the flotation stage was observed (Density of final tailing [Zn-T] was fairly low as 14.1%).

2) Rudnik Mine

(a) Sampling Points

Fig 7.5 shows main sampling points at the Rudnik Mine processing plant.

As additional sampling had been needed for grasping actual state of operation condition at site, nine sampling points were decided adding four points. Total sampling points are shown in Fig. 7.6.

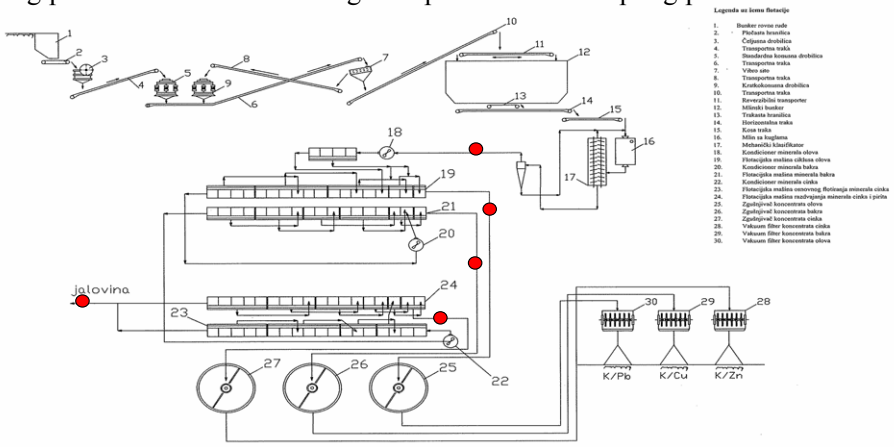


Fig.7.19 Sampling Points at the Rudnik Mine Processing Plant

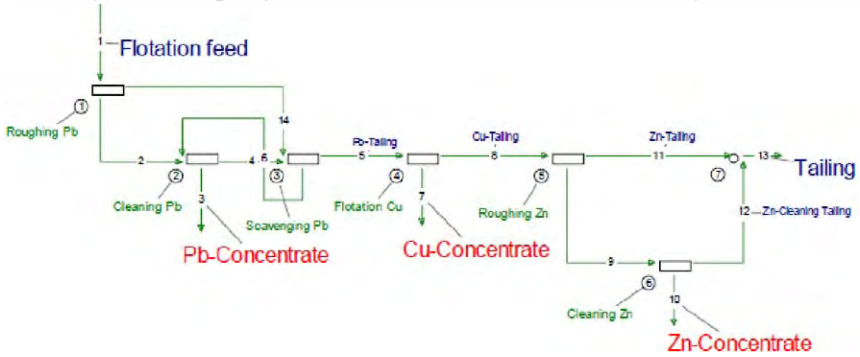


Fig7.20 Detailed Sampling Points of Rudnik Mine Processing Plant

(b) Analysis Result

Analysis result of process samples are shown in Table 7.16 comparing to past 5 years.

Table7.16 Chemical Analysis Results of Snap Samples from Rudnik Processing Plant

Parameter	Element	Period of sampling	Previous years(*)				
			2002	2003	2004	2005	2006
Elements concentration in ore	Pb, %	1,48	1,42	1,46	1,45	1,62	1,60
	Zn, %	1,58	1,53	1,50	1,65	1,76	1,62
	Cu, %	0,32	0,24	0,16	0,17	0,26	0,32
Elements concentration in concentrate	Pb, %	75,36	73,76	75,98	75,22	74,59	73,94
	Zn, %	54,69	48,06	47,99	47,47	46,73	47,47
	Cu, %	23,76	22,49	20,58	18,88	19,99	19,56
Recovery of elements in concentrate	Pb, %	88,41	93,10	91,95	90,23	88,98	89,43
	Zn, %	67,05	81,35	75,88	82,89	79,58	75,85
	Cu, %	59,79	62,51	50,84	45,82	49,21	55,16

(*) Previous year's data are given based on Reports received from Authorized Staffs in Mine RUDNIK

Analyses can be summarized as follows;

- Cu grade in the feed ore is higher lasting previous year than past five years even Pb and Zn grades are in the same range as past.
- Pb recovery tends to decrease in recent five years and the analysis result of snap sampling showed same tendency.
- Zn grade of Zn- concentrate is 7 points higher comparing to last five years, but Zn recovery is

10 points lower instead and tends to decrease.

- Cu grade in the Cu concentrate shows the highest value as 23.76%, and Cu recovery also shows high value since 2002.

Furthermore following items can be recommended according to the sampling results and plant observation.

- Feed size for flotation is a little coarse (80% pas size might be between 75 and 106 μ m).
- Excess consumption of industrial water in the Zn flotation stage was observed (Density of final tailing [Zn-T] was low as 25%).
- Final tailing consists of rougher flotation tailing of Zn flotation stage being mixed with cleaner tailing of Zn flotation. This combination might be obstacles of increasing recovery and may cause high Zn grade of final tailing.

(3) Leaching Test

48hr continuous Cu leaching test followed by SX-EW (Solvent Extraction-Electro Winning) method Cu recovery was executed using composite sample of core-drilling of RTB-Bor old tailing dam as feed sample.


Leaching test equipment

1) Leaching Test Conditions

Test conditions are as follows,

- Laboratory scale test conditions
  - Quantity of sample: 2kg
  - Particle size (2 levels): -74μm, +74μm
  - pH of Leaching solution (2 levels): 1, 2
  - Leaching time: 48 hours（leachate was taken every 6 hours for analysis）
- Bench scale test result
  - Quantity of feed sample： 25kg
  - Size (1 level)： -74 μ m
  - pH of leaching solution (1level)： 1
  - Leaching time： 48Hr (analysis is conducted each 6Hr)

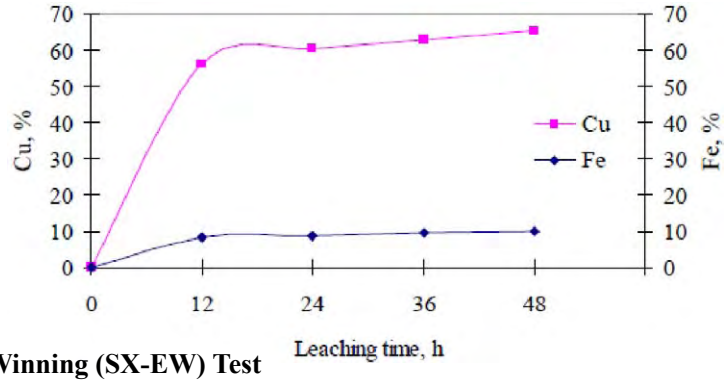
・B-Cu-L-1：Column type Cu leaching test equipments, ・B-Cu-L-2：Periodical sampling of leaching solution, ・B-Cu-L-3：Pregnant solution zone / upper part of column

2) Leaching Test Result

Fig 7.21 shows leaching test result. Cu leaching rate increase radically till 12 hrs and reach 60% just after 12 hrs. After 12hars, leaching rate tends to increase slightly up to 48hrs.

Fe leaching rate is under around 10% even after 48hrs.

Fig 7.21 Leaching test result (Recovery of Cu and Fe)



(4) Cu Solvent Extraction and Electro Winning (SX-EW) Test

1) SX-EW Test Method and Test Condition

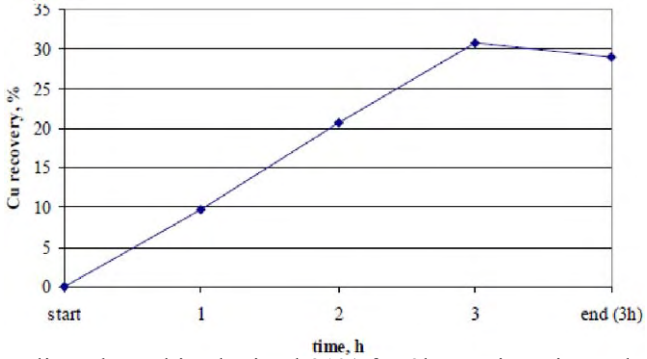
SX-EW test was carried out using pregnant solution from the bench scale leaching test which had been executed under pH 1 with -74μm as size, as feed sample. The test was carried out SX and SW in series.

Photos B-Cu-SX-1 to 3 shows SX-EW test scene and Cu deposited on the cathode.

2) SX-EW Test Result

SX-EW test result is shown in Fig.7.22.

Fig.7.22 SX test result



Cu recovery rate by SX increase linearly and is obtained 31% for 3hrs. It is estimated that Cu recovery rate might show more than 90% during 9 hrs, extending this line.

Summarizing analysis results of core-drilling, leaching test results and SX-EW test results, Cu contents in the old tailing dam is 0.304%, max Cu recovery in the leaching stage is 65.38% and in the SX stage should be 99.78% applying world wide average in case of the test result keeps linear tendency. And the recovery in the EW stage could also be applied 98%. Quantity of the No.1 old tailing dam is estimated as 4.5 million tons. Therefore recoverable Cu metal quantity in the No.1 old tailing dam could be estimated by following equation.

0.304%×4.5million tons×65.38%×99.78%×98% = 8,739 ton Cu

Namely, 8,700 tons of Cu is able to be recovered from No.1 old tailing dam, according to batch and bench scale test result.

(5) Au Flotation and Cyanide Leaching Test

According to the analysis result of core-drilling and sampling, 1.33g/t of Au contents in the Lece mine tailing dam was observed. Cyanidation test for efficient recovery of this gold was executed.

1) Test Method and Test Condition

Two steps Au recovery test was executed applying Au condensation by method of flotation with sulfurdization first, and then cyanide leaching. (Photos: L-Au-F-1 to 2, L-Au-CN-1 to 2)

- Quantity of feed ore : 2kg (for Laboratory Scale), 5kg (for Bench Scale test)

Figure III-32: Sulphatization furnace

Figure III-35: Flotation experiments

CN Leaching

Figure III-40. Cyanide leaching tests

・L-Au-F-1 : Sulfurdizing Process, ・L-Au-F-2 : Au Condense Flotation, ・L-Au-CN-1, 2 : Cyanide Leaching

Au content in the Lece Mine tailing dam is 1.33g/t and stock amount is estimated as 2 million tons. Au recovery at condensation flotation stage was 85.11%, and Au recovery at Cyanide leaching was 95.68%.

Therefore, amount of recoverable Au from the Lece Mine tailing dam can be estimated as following equation.

1.33g/t×2million ton×95.68%×85.1% = 2.2 ton Au

Namely, there is possibility to recover 2.2 ton of gold from Lece mine tailing dam, according to the results of batch test and bench scale test.

7.4.3 Mineral Processing and Tailings Dam Management

(1) Bor Mine Tailings Dam

RTB-Bor has old two tailings dams numbered as No.1 and No. 2 and utilizes alternatively. No.3 tailings dam is under application. Storage system is sand/slime separation method with cyclone classification which is standard and most stable method. No.1 tailings dam is used at the moment, however the dam storage quantity is approaching to its full capacity and collector installed the bottom of the dam has problem. Manager of the dam installs pumps and manages to treat overflow of the pond at the moment. The manager is planning to increase capacity of No.1 dam for more 8 years altering to use No.2 dam.

Permeable water does not come out through tailing dams, however, acid seepage occurs in the old open pits (Photo: BT-3, 4）, and acid seepage (pH 2.6) comes out from Over Burden stock yard. (BT-5）(observed around 0.2m^3/l). Acid seepage from Over Burden stock yard was taken as case study sample.

BT-1：Oldest tailing dam of RTB-Bor,・BT-2：Old tailing dam for Case Study (CS: core-drilling and sampling)・BT-3, BT-4：Permeable water in the open pit,・BT-5：Acid seepage from Over Burden stock yard（strong acid of pH2.6),・BT-6：Operating tailing dam No.1 (front), No.2 (behind)

Damage of bottom culvert and/or overflow collector should be adjust quickly because the damage influences directory to discharge capacity of tailing dam and affects stability of the tailing dam.

Following items are recommendable for fixing bottom culvert of No.1 tailing dam.

- To treat polluted water which occurs during construction since over flow water or water from bottom culvert run into the river nearby directory.
- Bottom culvert should be designed for easy inspection and monitoring from inside and designed tough and safety for man patrol if possible.
- It is desirable to guide outside water as hill side precipitation discharge separately from inside water.

2) Suva Luda Mine Tailing Dam

In the Suva Luda mine, Cu flotation tailing dam and Pb-Zn flotation tailing dam are separated but installed side by side and Cu flotation tailing dam is piled one stage higher (around 8m) than Pb-Zn flotation tailing dam (Photo: ST-1）.

Aquatic flora grows inside of dam (ST-2, ST-3). Furthermore, low bush trees as Tropa and Bagren were observed growing naturally from the foot of the bank and breeding toward upper part of the bank.

Observation halls for underground water level were installed on the bank surface which shows underground water level monitoring (ST-4). However, traces of erosion are observed at every where on the bank surface (rf. ST-5).

・ST-1 : Suva Luda mine tailing dam (Right : Pb-Zn flotation tailing dam, Left : Cu flotation tailing dam)・ST-2 : Pb-Zn flotation tailing dam, ・ST-3 : Cu flotation tailing dam, ST-4 : Underground water monitoring holes on the bank, ・ST-5 : Erosion trace on the bank

(2) Lece Mine Tailings Dam

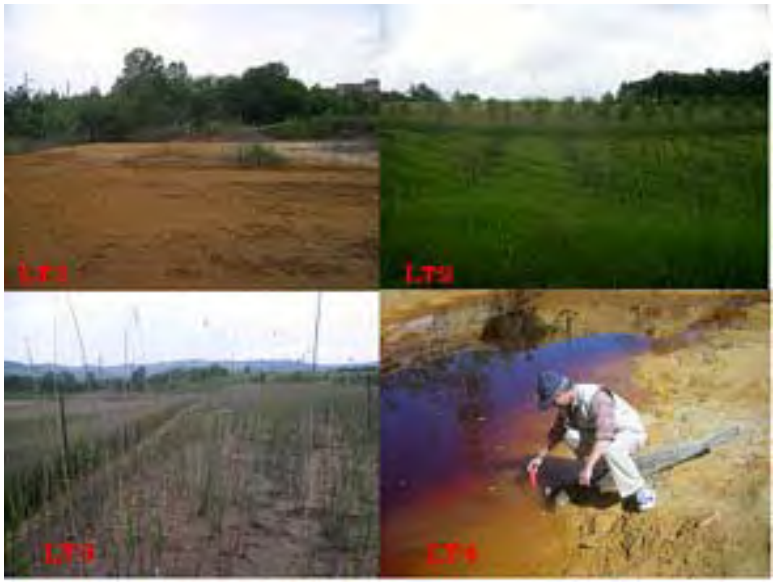
The Lece Mine Tailings dam consist of nine parts with a series of No1 to No.9 forming a

staircase with 3million tons in total. They said that the piling system had been used sand / slime separation method.

All dams are covered bush except No.3. There is not observed surface erosion and shallow slope with less than ten (10) m height difference and seventy (70) to eighty (80) m length may confirm stable condition. However, underground water level control installing water level monitoring well and / or Piezo meter etc. is not applied.

Leachate in the No.2 dam pond showed strong acidity as pH value of 2.6.

Lece Mine tailing dam scene is shown in LT- 1 to 4.



・LT-1：LECE tailing dam No.3 and processing plant,・LT-2：Scene of LECE tailing dam No5 from No.6,・LT-3：LECE dam No.4 bank and No.5 dam,・LT-4：Reachate of fLECE No2 dam(pH2.6).

(3) Grot Mine Processing Plant, Tailings dam

1) Grot Mine Processing Plant

Grot Mine Processing Plant is situated at 40 km from Vranje and 1,235 m high from the sea level. Ore fed to the plant and production are as follows,

- Grade of crude ore：Pb = 2 – 3 %, Zn = 3 – 4 %, Processes 100 thousand t / year.
- Produce：Pb – conc. = 2,250 - 5,170 t (Pb grade = 73.5 - 76.0 %)、Zn – conc. = 3,950 - 10,415 t (Zn Conc. 50.3－51.5 %).

Pb and Zn grade of feed changed around double at year 2003 and the grades are sustained. Pb grade of Pb – concentrate increased around 6% at year 2002, and Zn grade of Zn concentrate has sustained more than 50 % since 2001. Pb recovery was recovered the level of before 2000 (plus / minus 85 %), which had once fallen at year 2001. Zn recovery had improved drastically (nearly 15 %) at year 2002 (Table 7.17 and 7.18).

Table 7.17 Lead Flotation Result

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Feed Ore Pb (%)	3.49	2.72	2.25	3.52	2.25	2.10	2.03	4.49	3.94	3.69
Pb conc. Pb (%)	69.9	67.6	69.6	68.8	69.1	71.0	75.7	75.1	76.0	76.5
Pb-conc Pb-Rec.	86.0	84.9	80.4	86.5	86.1	81.3	83.3	84.1	86.7	85.1

Table 7.18 Zinc Flotation Result

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Feed Ore Zn (%)	1.94	2.80	2.37	2.46	2.37	3.00	2.71	4.72	5.30	5.00
Conc. Zn Zn (%)	46.5	47.0	48.2	46.9	47.5	51.8	51.9	50.3	51.4	51.5
Zn-conc Zn-Rec.	70.3	83.2	79.8	71.8	79.5	71.7	84.9	84.2	86.8	84.8

Feed ore grade of Pb and Zn are increasing, and concentrate grades also increase. However, the reason is not confirmed concretely. The origin of increasing grades should be analyzed and be utilized for quality control of exploiting and mineral processing while executing mineralogical study.

2) Tailings Dam

Piling system is sand / slime separation system using cyclone same as Bor and Lece Mines (Photos: GT-1, 2). Separation efficiency was good (GT-2). However, under water level control was not introduced (GT-4). In the near future, underground water monitoring tube and Piezo-meter were planned to install. Underground water monitoring and control should be commenced for keeping tailing dam stability urgently (GT-3). And overflow water of the pond were observed to be turbid, which indicate the overflow control is insufficient. (GT-3).

While, the data at site of Lece mine and Grot mine were offered, however, unfortunately necessary data were not obtained since almost all data had been submitted to the privatization agency

(4) Rudnik Mine Processing Plant and Tailings Dam

The flowsheet of the Rudnik Mine Processing Plant is orthodox flow as shown in Fig.7.23, Crushing --> Grinding --> Pb flotation --> Zn flotation --> Tailing Treatment.

Equipment of the Rudnik Mine processing plant is considerable new being installed compact and rational, and installed auto-sampler at necessary place. There is a difference between the privatized company, which put the focus on the cost / performances, and state owned

The process flow, which can obtain higher concentrate grades than recovery, is applied. There is some space to improve recovery. In particular, Zn flotation circuit may have possibility to improve recovery 2 to 3 % higher than actual modifying and renovating its system.

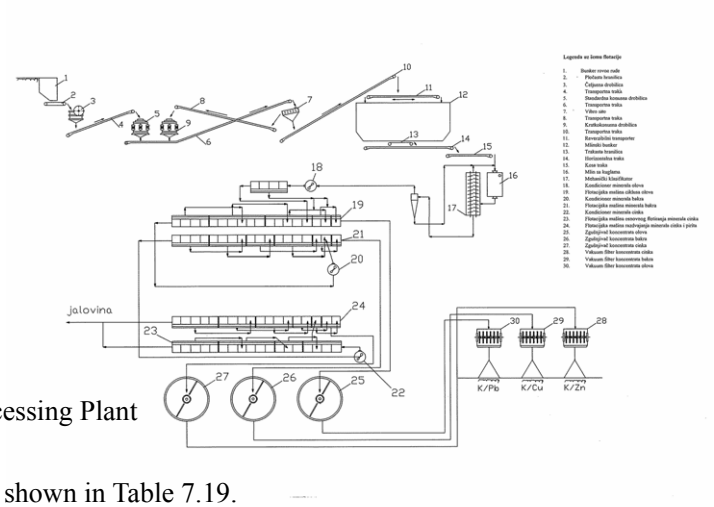


Fig.7.23 Flow-sheet of the Rudnik Mine Processing Plant

The latest 10 years processing result is shown in Table 7.19.

Table 7.19 The Latest 10 years Processing Result of the Rudnik Mine

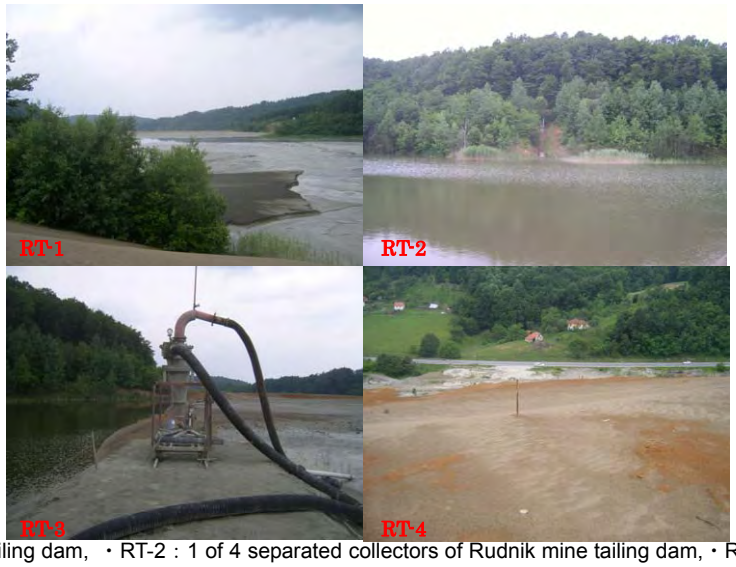
Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Feed Ore Weight (t)	207,115	210,085	173,225	192,897	195,903	181,089	104,980	111,240	162,481	171,769
Feed Ore Pb (%)	1.80	1.61	1.58	1.48	1.46	1.42	1.46	1.45	1.62	1.60
Feed Ore Zn (%)	1.73	1.60	1.66	1.59	1.63	1.53	1.50	1.65	1.76	1.62
Feed Ore Cu(%)	0.34	0.31	0.30	0.25	0.34	0.24	0.16	0.17	0.26	0.32
Conc. Pb Weight (t)	4,640	4,185	3,402	3,535	3,562	3,246	1,855	1,935	3,140	3,333
Pb conc. Pb (%)	74.1	73.5	72.9	73.0	73.0	73.8	76.0	75.2	74.6	73.7
Conc. Zn Weight (t)	6,040	5,785	5,015	5,205	5,581	4,690	2,490	3,205	4,870	4,446
Zn conc. Zn (%)	47.0	46.6	46.8	47.9	46.3	48.1	48.0	47.5	46.7	47.5
Conc. Cu Weight (t)	1,920	1,605	1,245	1,175	2,005	1,208	415	459	1,040	1,550
Cu conc. Cu(%)	19.4	18.5	19.7	21.3	21.5	22.5	20.6	18.9	20.0	19.6
Pb-conc Pb-Rec.	92.2	90.9	90.6	90.3	90.9	93.1	92.0	90.2	89.0	89.4
Zn-conc Zn-Rec.	79.2	80.1	81.5	81.3	80.9	81.4	75.9	82.9	79.6	75.8
Cu-conc Cu-Rec.		45.6	47.3	51.8	64.6	62.5	50.8	45.8	49.2	55.2

According to the Table 7.19, production for two years between 2003 and 2004 downed nearly half of other years' production. Similarly, Cu grade in the feed ore for same two years of 2003 and 2004 also downed half of other years. The decrease was caused by influences of the transition form state owned to privatize. However, operation result after privatization is same as that of state owned era. Still privatization effect does not appear for production improvement.

(b) Tailing Dam

Rudnik Mine tailing dam is operated introducing sand / slime separation system (Photo: RT-3), Many Piezo-meters are installed on the bank (RT-4) and underground water level monitoring is executed periodically. It can be said that under ground water level control is enough. Furthermore, overflow control is fine installing overflow water collectors at 4 points.

A crest of the Bank level is more than 100m and surface of tailing stocks are reaching mountain ridges which consist tailing dam (RT-1 to 3), and capacity rest seems not to be enough. There are a couple of private houses and passing by national road in front of the bank (RT-4), there is in danger to arise disaster once collapse would happen. Tailing dam management should therefore be done severely.



・RT-1：Rudnik Mine tailing dam, ・RT-2：1 of 4 separated collectors of Rudnik mine tailing dam, ・RT-3：Cyclone for separating sand (coarse grain) and slime (fine grain) (Now constructing inspection road), ・RT-4：Underground water monitoring holes and Piezo-meters on the bank of Rudnik Mine tailing dam

(5) Issues Identification and Interpretation in Processing Plant and Tailing Dam Management

1) Issues Identification and Interpretation in Processing Plant Management

(a) Bor Mine Processing Plant

Bor Mine processing plant has operated Cu treatment only during ’72 to ’86, and has treated Pb and Zn for ’86 to ’02. The operation result has gone down caused operation rate decreasing by equipment aging. Renewal of old equipments is under preparation to be executed 6 months later, however the plan is suspended because of investment shortage.

A Russian consultant company has done feasibility study on the Mjdanpek processing plant improvement. The report had recommended that expansion and improvement could realize for two years with three million Euro.

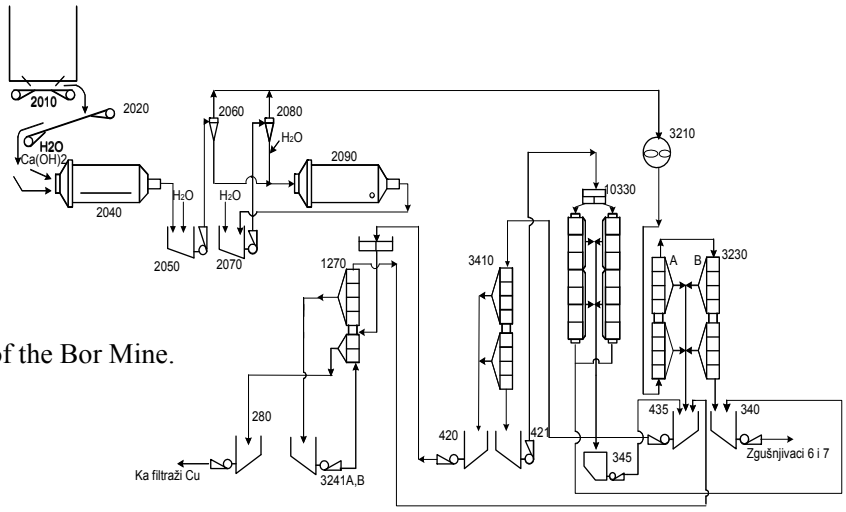


Fig 7.24 Processing Plant Flow of the Bor Mine.

Fig 7.25 shows the tendency of mine production and Cu grade of feed ore of the Bor Mine, and tendency of Cu concentrate grade and Cu recovery are shown in Fig 7.26.

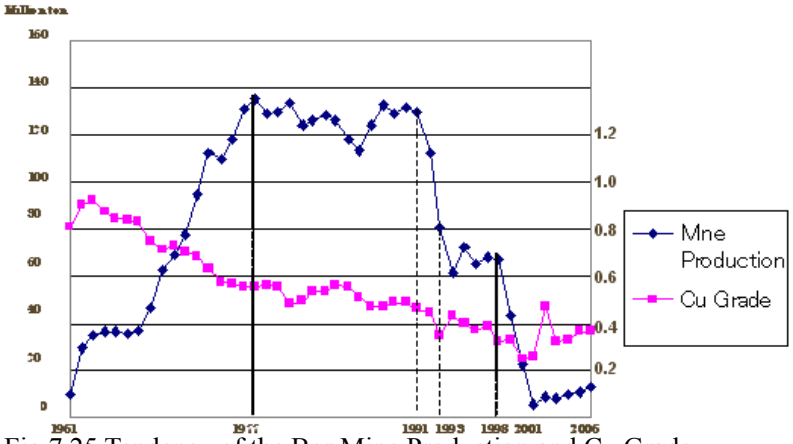


Fig 7.25 Tendency of the Bor Mine Production and Cu Grade

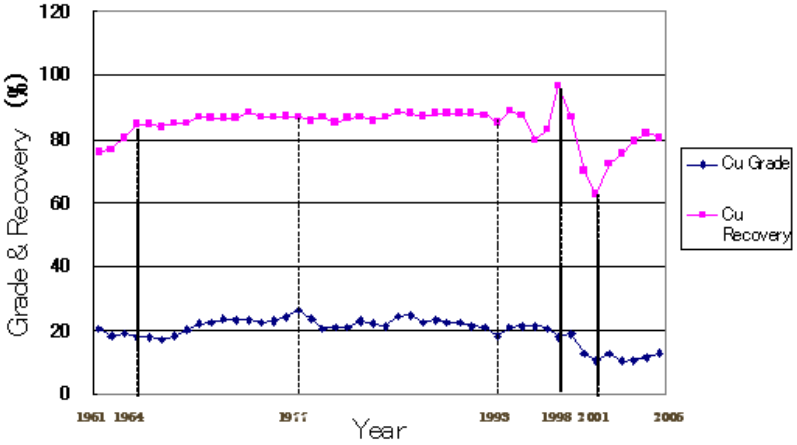


Fig 7.26 Tendency of Cu Grade of Cu-Concentrate and Cu Recovery

Cu grade in the feed ore was decreasing since the year 1963 when the grade had shown over 0.9 %. However, the tendency rebound to increasing at an opportunity of 0.22 % in the year 2001 and is getting 0.4 % in 2006. Cu grade in the feed ore has slightly decreasing during 1977 and 1991 when mine production rate has kept 12 thousand ton/year but comparatively stable between 0.58 and 0.46 %. Simultaneously, Cu grade in the Cu concentrate has been kept between 21 and 26 %.However, Cu grade of Cu concentrate has been less than 20 % since 1998. On the other hand, Cu recovery has been stable as 86 to 87 % since 1964, but began disturbance condition hunching between 88% and 62% since 1993. The recovery has improved gradually since 2001, however still is lower less than 80 %.

Recently the operation result has redacted largely comparing to past stable condition, origin of the decreasing of the grade, and its influences on the processing should be clarified by mineralogical study and appropriate processing condition should be confirmed by mineral processing test. Continuous operation keeps stable operation result in the processing plant. However, since 1991, feed rate has become nearly half of plant capacity and the state affects on the operation result. Now, plant side is managing to operate one line flotation system of two lines. However, big

capacity of milling stage is difficult to precise quantity control to fit appropriate condition causing decrease of operation result. Therefore, continuous operation with step driving fitting mill capacity (i.e. 4,000t/d, 8,000t/d, 12,000t/d etc.) should be employed considering multiple parallel system from mill stage to filtering stage which can be fitting fluctuation of throughput.

The leakage of air was observed in the resting equipments. Frequent maintenance of piping and valves are also effective for energy saving.

(b) Grot Mine Processing Plant

The analysis result of snap sampling with operation results of past 5years are shown in Table 7.20.

Table 7.20 Analysis Result of Grot Mine Processing Plant Samples

Parameter	Element	Period of sampling	Previous 5 years(*)
Elements concentration in ore	Pb, %	2,26	2,0 – 3,0
	Zn, %	2,73	3,0 – 4,0
Elements concentration in concentrate	Conc. Pb / Pb %	70,16	73,5 – 76,0
	Conc. Pb / Zn %	10,30	2,5 – 3,0
	Conc. Zn / Pb %	3,19	4,0 – 5,0
	Conc. Zn / Zn %	53,59	50,3 – 51,3
Recovery of elements in concentrate	Pb, %	83,82	84 – 86
	Zn, %	71,98	86 – 88

(*) **Previous year's data are given based on Reports received from Authorized Staffs in Mine GROT**

Based on the plant observation and analysis result of the snap sampling, following problems are pointed out relating the Rudnik Mine processing plant.

- Flotation feed size looks some how coarse.
- Zn flotation flow was composed grade preference and seems to get lower recovery.
- Solid density of flotation is generally low.
- Consumption of industrial water seems to be extreme.

Therefore, it is needed to revise operation management system.

2) Problem Identification and Interpretation in Tailing Dam Management

(a) Bor mine Tailing Dam

- Acid reachate comes out from old open pit and waste deposit. Acid reachate treatment should be necessary.
- Overflow discharge function of No.1 tailing dam does not work enough because of broken of bottom collecting culvert. It is recommendable to make daily inspection easily at the same time to function recovery while repairing works.

(b) Suva Luda Mine Tailing Dam

- It is necessary to realize vegetation rapidly for protection of erosion since bank erosion is progressing.
- On the other hand, auction for selling the mine is planned by the Privatization Agency.

- The first auction has been held on 22nd October 2007 and in vain.
- The second auction is planned to be held on November, 2007.

(c) Grot Mine Tailing Dam

- Planned installation of permeable water monitoring hole and a piezo-meter should be hurried up.
- Frequent over flow water control is needed.

(d) Lece Mine Tailing Dam

- Reachate is strong acid (pH2.6), it is therefore necessary to study and to monitor impact on the environmental as affect of well water penetrating into underground.

While the Suva Luda, Lece and Grot Mines are planned to be at auction on November, therefore, it is very important to make bidder recognize clearly the tailing dam management.

(e) Rudnik Mine Tailing Dam

Separate collectors are inconvenient for control, therefore, it is recommendable to install bigger collector and make other smaller collectors for spare.

It is necessary to prepare the second tailing dam beforehand for further operation.

7.4.4 Acquisition of the Data of Unutilized Resources

Information for unused resources in Serbia has not given to the team by mines, MEM and Privatization Agency, because the privatization process is just undergoing. In addition, there is not any data for rare metals contained in tailings dams, because most rare metals have not analyzed so far. Indium which was analyzed from the gold coarse concentrate (9.4g/t Au, 2.4% Zn) attained from the Lece Mine tailings dam was 17.8g/t. If In is assumed to be associated by sphalerite, Zn concentrate (about 50% Zn) may contains In of 370g/t, or more than 100g/t In may be included in Zn concentrate at least. It should be ascertained. The more In is contained in Zn concentrate, the higher evaluation the Zn concentrate contract can attain. Generally, smelters can recover In from Zn concentrate if In is contained more than 5g/t. Above-mentioned data indicates possibility of recovery in smelters.

7.4.5 Summary of the Study Result

(1) Mineral Processing and Tailing Dam Management

Problems related to mineral processing are as follows.

Fluctuation of mine quantity, which is out of processing plant control, affects instability of plant operation (Grot and Bor Mines). Aged equipment accelerates making operation result worse (Grot and Bor Mines). Partially operation by decreasing of mine production forces operation condition become worse and causes equipment corrosion and air leakage (Grot and Bor Mines). Furthermore, veterans are relied on for operation management and alteration of generation is delayed

(Grot and Bor Mines). Some plant is put priority first on the concentrate than recovery (Rudnik Mine).

Generally, necessary measurement for daily operation control (flotation feed size, slurry density, pH) is not carried out and operation is controlled by experiences and feeling (Grot, Rudnik and Bor Mines) (Fig 7.11 and 7.12). Investigation for the cause when the operation condition and the result fluctuate drastically, in particular, mineralogical study is needed.

Problems related to tailing dams are as follows.

Many mines do not monitor underground water level by monitoring hole and Piezo-meter. Protection for erosion should be needed (Suva Ruda Mine). Improvement for effluent discharge capacity should be applied (Suva Ruda and Bor Mines). Tailing dams of some mines hold acid Reachate. Once, water balance measuring reachate quantity, evaporating rate, permeable water quantitiy etc. should be checked. Several places out side of tailing dam cause acid reachate (Old open pit, Overburden stock yard etc).

As for acid water, monitoring for environmental impact around including penetration into underground is needed

(2) Case Study

As the result of case study, following items can be said.

- Cu grade in the old tailing dam No. 1 of RTB-Bor is 0.304 %. According to Cu leaching test result, Cu recovery is 65 % and Cu recovery with SX-EW test result is more than 97 % and total recovery was estimated more than 63 %. This calculation estimates that approximately 8.7 thousand ton of copper would be attained from 4.5 million ton of tailings in the old tailing dam No.1.
- There exist not only No.1 tailing dam but also No.2 and they say total tailing amount is 24 million ton. Furthermore exist waste rocks, some of which contains more than 1 g/t of Au. Cu, Au grades and quantity synthetic investigation and recovery test from waste should be confirmed. Those waste cause water pollution by generating acid water and harmful heavy metal ions.

Table 7.22 Waste of RTB-Bor

Waste Condition in RTB-Bor

	Overburdens						Total
	Tall deposit	North deposit	RTH deposit	Inner deposit	V.Krivelj deposit	Cerovo deposit	
Quantity (Million tons)	150	20	60	28	170	22	450
Cu (%)	0.15	≥ 0.3	< 0.1	0.2	< 0.1	0.18	0.11

Table7.23 Tailings of RTB-Bor

Tailing Condition in RTB-Bor

	Flotation tailings			Total
	Old flotation tailing	RTH flotation tailing	V.Krivelj flotation tailing	
Quantity (Million tons)	27	50	130	207
Cu (%)	0.24	< 0.2	0.15	0.15

- Au flotation test result of Lece tailing shows more than 96 % of Au recovery, and cyanide leaching test result indicates more than 85 % Au recovery. Toatal Au recovery is estimated as more than 80 %. Therefore, approximately 2.2 ton of gold would be recoverable from 2 million tons of Lece tailing dam. Since this time case study was carried out according to No.2,3 and 4 tailing dams and commented on the whole tailing dams from No.1 to No.9. It is recommended, therefore, to execute synthetic study which coveres on the whole tailing dams to confirm this case study result.
- Grot Mine processing plant samples were taken just after beginning operation, Pb grade and Zn recovery were inferior than those of past 5 years. This result indicates that unstable operation affects on insufficient result and continuous operation is needed to keep stable operation.
- As for Rudnik Mine operation plant, flotation feed size is some how coarser, lower Zn recovery by flow of Zn grade priority first. Slurry density in the flotation stage is generally lower and extreme industrial water consumption is worried. Those are operation improvement issues.
- According to very rough financial calculation, as for the Cu recovery from old tailing dam of RTB-Bor, under conditions of 1,000 t/d, 15 years life and Cu price of 2,400 US$/t, IRR resulted more than 30% indicating very high feasibility. On the other hand, as for Au recovery from Lece tailing dam under conditions of 500 t/d, 15 years life and Au price of 400 US$/Oz, IRR resulted also more than 30% pointing very high possibility and feasibility. These estimation were calculated using the best condition of laboratory test results and rough market conditions which had been obtained for short period. The team strongly recommends to realize more accurate economic estimation acquiring more accurate data with executing continuous pilot plant test and exact market research.

  Table 24 and 25 show examples of DCF-IRR estimation applying 2,400US$/t of Cu price, 1,000t/d of thoroughput and 15 years of life for Cu recovering from RTB-Bor mine old tailing dam and applying 400US$/t of Au price, 500t/d of thoroughput and 15 years of life for Au recovering from Lece mine tailing dam

Table 7.24 DCF-IRR estimation example of Cu recovering form the Bor mine old tailing dam

DCF/IRR Calculation Table (In case of 1000 t/d)

Unitario:US $

Items \ Year			−1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
[Income]																				
	Sales revenue of Concentrates	*1			3,038	3,038	3,038	3,038	3,038	3,038	3,038	3,038	3,038	3,038	3,038	3,038	3,038	3,038	3,038	45,563
	Others	1 % *2			30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	456
	Income Total		0	0	3,068	3,068	3,068	3,068	3,068	3,068	3,068	3,068	3,068	3,068	3,068	3,068	3,068	3,068	3,068	46,018
[Cost]																				
	Inicial Investment	1,433) *3	(550)	1																1
	Operation Cost	*4			1,942	1,942	1,942	1,942	1,942	1,942	1,942	1,942	1,942	1,942	1,942	1,942	1,942	1,942	1,942	29,135
	Depreciation	143 *5			143	143	143	143	143	143	143	143	143	143	0	0	0	0	0	1,433
	Tax (%)	16 *6			486	486	486	486	486	486	486	486	486	486	486	486	486	486	486	7,290
	Interest (%)	10 *7		143	129	115	100	86	72	57	43	29	14	0	0	0	0	0	0	788
	Others (%)	5 *8			153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	2,301
	Cost Total		(550)	144	2,854	2,840	2,825	2,811	2,797	2,782	2,768	2,754	2,739	2,725	2,582	2,582	2,582	2,582	2,582	40,947
[Benefit]																				
	Yearly Benefit		(−550)	−144	214	228	243	257	271	286	300	314	329	343	486	486	486	486	486	5,071
	Acumulate Benefit		(−550)	−144	70	298	541	798	1,069	1,354	1,654	1,968	2,297	2,640	3,126	3,612	4,098	4,585	5,071	
[Net Present Value: NPV]																				
	(Oportunity losse 1)	15 %	( )	−144	186	173	159	147	135	123	113	103	93	85	105	91	79	69	60	
	(Oportunity losse 2)	5 %	( )	−144	204	207	210	211	212	213	213	213	212	210	284	271	258	246	234	
	IRR: 30%	Yearly Benefit:	−550	−144	214	228	243	257	271	286	300	314	329	343	486	486	486	486	486	

Table 7.25 DCF-IRR estimation example of Au recovering form the Lece mine tailing dam

DCF/IRR Calculation Table (In case of 500 t/d of Lece taling dam)

Unitario:US $

Items \ Year			−1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
[Income]																				
	Sales revenue of Gold	*1			17,416.84	17,416.84	17,416.84	17,416.84	17,416.84	17,416.84	17,416.84	17,416.84	17,416.84	17,416.84	17,416.84	17,416.84	17,416.84	17,416.84	17,416.84	261,252.66
	Others	1 % *2			174.17	174.17	174.17	174.17	174.17	174.17	174.17	174.17	174.17	174.17	174.17	174.17	174.17	174.17	174.17	2,612.53
	Income Total		0.00	0.00	17,591.01	17,591.01	17,591.01	17,591.01	17,591.01	17,591.01	17,591.01	17,591.01	17,591.01	17,591.01	17,591.01	17,591.01	17,591.01	17,591.01	17,591.01	263,865.19
[Cost]																				
	Inicial Investment	6,001) *3	(0.00)	6,000.50																6,000.50
	Operation Cost	*4			11,427.67	11,427.67	11,427.67	11,427.67	11,427.67	11,427.67	11,427.67	11,427.67	11,427.67	11,427.67	11,427.67	11,427.67	11,427.67	11,427.67	11,427.67	171,415.01
	Depreciation	600 *5			600.05	600.05	600.05	600.05	600.05	600.05	600.05	600.05	600.05	600.05	600.05	600.05	600.05	600.05	600.05	9,000.75
	Tax (%)	16 *6			2,786.70	2,786.70	2,786.70	2,786.70	2,786.70	2,786.70	2,786.70	2,786.70	2,786.70	2,786.70	2,786.70	2,786.70	2,786.70	2,786.70	2,786.70	41,800.43
	Interest (%)	10 *7		600.05	540.05	480.04	420.04	360.03	300.03	240.02	180.02	120.01	60.01	0.00	0.00	0.00	0.00	0.00	0.00	3,300.28
	Others (%)	1 *8			175.91	175.91	175.91	175.91	175.91	175.91	175.91	175.91	175.91	175.91	175.91	175.91	175.91	175.91	175.91	2,638.65
	Cost Total		(0.00)	6,600.55	15,530.37	15,470.36	15,410.36	15,350.35	15,290.35	15,230.34	15,170.34	15,110.33	15,050.33	14,990.32	14,990.32	14,990.32	14,990.32	14,990.32	14,990.32	234,155.62
[Benefit]																				
	Yearly Benefit		(0.00)	(6,600.55)	2,060.64	2,120.65	2,180.65	2,240.66	2,300.66	2,360.67	2,420.67	2,480.68	2,540.68	2,600.69	2,600.69	2,600.69	2,600.69	2,600.69	2,600.69	29,709.57
	Acumulate Benefit		(0.00)	(6,600.55)	(4,539.91)	(2,419.26)	(238.60)	2,002.06	4,302.72	6,663.39	9,084.07	11,564.75	14,105.43	16,706.12	19,306.81	21,907.50	24,508.19	27,108.88	29,709.57	
[Net Present Value: NPV]																				
	(Oportunity losse 1)	15 %	( )	(6,600.55)	1,791.86	1,603.52	1,433.82	1,281.10	1,143.84	1,020.58	910.02	810.94	722.22	642.85	559.00	486.09	422.68	367.55	319.61	
	(Oportunity losse 2)	5 %	( )	(6,600.55)	1,962.52	1,923.49	1,883.73	1,843.40	1,802.63	1,761.57	1,720.33	1,679.02	1,637.75	1,596.60	1,520.57	1,448.16	1,379.20	1,313.53	1,250.98	
	IRR: 33%	Yearly Benefit	0.00	(6,600.55)	2,060.64	2,120.65	2,180.65	2,240.66	2,300.66	2,360.67	2,420.67	2,480.68	2,540.68	2,600.69	2,600.69	2,600.69	2,600.69	2,600.69	2,600.69	

7.5 Issues in Serbian Mining Companies

The most serious problem of the mining company's management in Serbia is accumulated debt. How to treat and handle such debt can be recognized as the most important point in the mining company's management. In this report, the debt problem is to be investigated.

7.5.1 Accumulated Debt of Mining Sectors

Mining companies in Serbia have gone bankruptcy mainly due to their accumulated debt. In the case of Grot mining, when they changed their status from a child company of Trepca to an independent company, the part of debts of Trepca was compulsory transferred to Grot, which, in turn, becomes a big burden for Grot management. In another words, at the beginning of starting as an independent company, Grot had already so heavy burden of debt that they were supposed to go bankruptcy in the near future due to such debt. If the debt of mining sectors in Serbia is treated usually as the debt to be repaid, it would be quite difficult for the mining companies in Serbia to improve their management and to find investors on such companies with a heavy burden of debt. As one of the solutions of debt problem, Debt-Equity Swap can be suggested as follows:

7.5.2 Debt-Equity Swap

The term 'Debt-Equity Swap' means a method that allows a creditor to exchange a monetary claim against company with shares of stock in that company. It is a method to exchanges debt with equity under an agreement between a creditor and a debtor. The transaction has a built-in mechanism to restructure the debtor's business in a manner more amenable to the creditors than the simple waiver of claims.

The following conditions would be required, provided that the Swap be adopted to the mining sector in Serbia;

(1) The Swap is adoptable only to the company that issues shares.

Since the Swap is a method to exchange debt with equity, it can be adopted only to the stock company that can issue shares. So far, the status of the mining companies in Serbia is a so-called social company that does not issue shares. Thus, the Swap can not be adopted, unless its status is changed to the stock company. For the adoption of the Swap to mining company in Serbia, its status needs to be changed to that of share stocked company.

In the mean time, the Serbian government has a policy to privatize mining companies at present. It seems that the privatization of Serbian government is the same meaning as the selling of the company itself. To our understanding, the privatization takes place in such manner that shares owned by the state are sold, wholly or partially, to the public. In this regard, the privatization in Serbia seems to be deferent from such cases. In the privatization, there are a few cases that some measures are taken to raise the value of the company's shares, if the company to be privatized has a negative worth. For instance, the debt is transferred to the special purpose company that is established to take over that debt, or the debt is reduced by the Swap. It is deemed that the privatization in Serbia means the sell of the company itself, not the sell of company's shares. It would be confirmed at our next site survey as to the system of social company's privatization in Serbia that is not issuing shares.

(2) The possibility should exist that the company successfully restructures its business.

The Swap is the method to provide the company with the opportunity to restructure successfully its business and the creditor with the opportunity to recover an amount equivalent to or more its claim. The Swap should be adopted only to the company that is expected to have a prospectus business future, if the debt is reduced. Whether or not, the Swap is adopted to a company, should be decide based on its potential business future.

(3) Restructuring of the management

The company that adopts the Swap requires to restructure and strengthen the management. The restructuring of its business after the Swap should be made in every department including accounting, business promotion, and productivities. In order to succeed in this restructuring, the restructuring of the management is also required.

(4) Adoption of the Swap to the Grot Mine

The Grot mine is under procedure of bankruptcy and continuing the operation under the supervision of the bankruptcy agency of Serbia. If the potential growing scenario was accepted and the Swap was applied to the Grot, there would existed some possibility of avoiding the bankruptcy.

In the case of Grot, their accumulated debt amounts to approximately 15 billion Serbian Dr. Compared to the company size, it is too huge amount (Table7.26). In order to apply the Swap to the Grot, the debt should be decreased. The decrease of debt would be possible if the responsibility of creditors is taken into account. To some extent, the creditors must be responsible for the accumulated debt of the Grot, because they continued giving credit to the Grot ignore ring financial situation of the Grot.

If the Swap is adopted after the decrease of debt, another scenario could be possible, because the Grot is presently making profit with the accumulated debt separated under the bankruptcy procedure.

Table7.26 Balance Sheet of the Grot as of 2006- Unit-1,000 Dinars

Assets	
Fixed Assets	**247,387**
Real estates, equipments, machinery, etc	247,380
Biological Assets	7
Liquidity Assets	**217,105**
Inventories	104,577
Cash, deposits	84,419
Advance payment (tax)	28,109
Total Assts	464,492

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Real estates, equipments, machinery, etc	247,380
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Liquidity Assets	**217,105**
Inventories	104,577
Cash, deposits	84,419

Advance payment (tax)	28,109
Total Assts	464,492
Liabilities	
Long term debts	**6,902**
Long term loans	0
Other long term debts	6,902
Short term debts	**123,566**
Short term loans	12,478
Other short term debts (business)	89,284
Other short term debts (others)	10,246
Tax (VAT,etc)	11,558
Total Liabilities	130,468
Capital	**334,024**
Paid up capital	222,841
Provisions	38,404
Retained earnings	72,779
Total of Liabilities and capital	464,492

(Source: Grot Mine)

7.5.3 Improvement of Grot Management

(1) Review of Financial Performance.

According to the Privatization Agency, the privatization of the Grot Mine is to take place next March and the detailed financial data is not made public before that time. Under the situation, the detailed financial data is not available at present. The review of financial situation of the Grot is made based on the financial data available from the present management. In the meantime, it seems that such detailed data as notes to B/S, P/L have not been prepared in good order, because such data are required only in terms of accountability of management to shareholders and creditors in capitalism system.

Under the socialism time, mining companies were called social companies and their owners were the society including workers. It meant that society had no substance as owners of mining companies and there existed no distinction between the owner (capitalist) and management. Therefore, the management had no accountability to the owners and the detailed financial data were not required to be prepared.

For instance, even the Rudnik Mine, which is only one mining company listed at the Belgrade Stock Exchange with very good performance, do not prepare and submit to the Exchange such detailed data. In replying to our question if the Exchange requests such data to be submitted, they explained that as far as we were making profits as expected, there were no need to prepare and submit such data. Considering from the case of listed company, it would be not incorrect to judge that the Grot has not prepared the same.

Following is the financial situation of the Grot before the bankruptcy during 2001-2005.

Table7.27 Grot Mine P/L Statement for 5 Years（in 1,000 Dinars）

Period	2000	2001	2002	2003	2004	2005*
Business incomes	0	81,967	92,947	135,200	299,215	354,155
Business expenditures	314	87,594	93,951	137,529	314,751	268,174
TOTAL Business Activities	(314)	(5,627)	(644)	(2,329)	(15,536)	85,981
Financial incomes	0	14	53	0	1,052	573
Financial expenditures	0	1,150	1,722	606	1,218	1,403
TOTAL FINANCIAL ACTIVITIES	0	(1,136)	(1,669)	(606)	(166)	(830)
BUSINESS AND FINANCIAL ACTIVITIES TOTAL	(314)	(6,763)	(2,313)	(2,935)	(15,702)	85,151
Other (non-business) income	0	1,608	66	247	34,632	1,035
Other (non-business) expenditures	0	2	0	460	18,930	0
OTHER ACTIVITIES TOTAL	0	1,606	66	(213)	15,702	1,035
Profit before tax	(314)	(5,157)	(2,607)	(3,148)	0	86,186
Tax	0	0	0	0	0	12,066
NET TOTAL	(314)	(5,157)	(2,247)	(3,148)	0	74,120
*data for 2005 are for 21.11.2005 (day of starting procedure of bankruptcy) TAX for 2005 is projected amount						

（source: Grot Mine）

The actual state of the Grot Mine management can be guessed from the P/L statement to be as follows;

During years of 2001－2004, as the result that the expenses exceeded the revenue, profit/loss account continued to be red figures or zero before tax.

Table 7.28 Grot Mine P/L Statement for 4 Years

Year	Revenues	Expenses	Profit/Loss
2001	83,589	88,746	(5,157)
2002	93,066	95,673	(2,607)
2003	135,447	138,595	(3,148)
2004	334,899	334,899	0
2005	355,763	269,577	86,186

The reason of the continued red figures was that the production cost and other cost were keeping going up year after year.

Table7.29 Weight of Production Cost in Sales (in 1,000Dinars)

Production Cost	2001	2002	2003	2004	2005
Material for Production	6,889	5,321	3,391	10,334	16,631
The basic material	15,143	7,465	21,592	70,176	49,588
Supplies	0	1	36	173	0
Waste	177	0	5	918	900
Earnings of workers	22,342	22,365	29,203	86,361	80,818
Nourishments of employee	1,548	1,766	2,296	3,584	1,059
Transportation expenses	4,455	5,827	4,289	20,749	17,268
Research expenses	0	529	453	10,787	9,730
Total	50,554	43,274	62,266	203,082	175,994
Sales Products	76,529	91,262	130,590	294,247	415,614

（source: Grot Mine）

The ratio of production cost to sales products changes as follows;

Table 7.28 Ratio of Production Cost to Sales (%)

year	2001	2002	2003	2004	2005
Ratio of production cost	66	47	48	69	42

In 2002, 2003 and 2005, the ratio were keeping around 40%、but in 2001 and 2004, it exceeded 60%. This increased ratio was caused by basic material cost in 2001 and 2004. Particularly, in 2004, the basic material cost amounted to 70,176 thousand dinars. Compared to 2003 and 2005, this basic material cost was extraordinary high.

Table 7.29 Material Cost in Sales

Year	2001	2002	2003	2004	2005
A)basic material	15,143	7,465	21,592	70,176	49,588
B)Product Sales	76,529	91,261	130,590	294,247	415,614
C) A ÷ B	19.8%	8.2%	16.5%	23.8%	11.9%

The ratio of production cost fluctuated greatly every year due to basic material cost and it would be very difficult to anticipate the profit /loss account if it continues fluctuating by year. Basic material and earnings of the workers are main items of production cost. If basic material cost fluctuates greatly, the production cost would be affected unexpectedly by year, and the management would not be stable. In order to make the management stable, some measures should be taken, such as strengthen the purchasing section, hedging way for price, etc.

Table7.30 Other Expenses in Sales (1,000 Dinars)

Year	2001	2002	2003	2004	2005
Other expenses	8,683	17,840	38,159	65,149	61,011
Depreciation	8,359	5,650	6,454	7,406	32,832
Earnings management	5,032	6,139	8,175	31,248	32,437
Fuel, lubricating	7,486	11,626	10,292	12,247	17,949
Electricity	8,632	11,619	14,252	15,770	22,323
Total	38,192	52,874	77,332	131,820	166,552
Total÷Sales	50%	57.9%	59.2%	44.8%	40%

As shown above, the ratio of other cost is very high and due to this fact, the productivities as manufacturing company is so low. Especially, in 2002 and 2003, the other cost (indirect cost of production) exceeded the production cost (direct cost of production). It means that the productivities of Grot were very poor and ineffective.

Table 7.31 Production Cost and Other Expenses in Sales

Item	2001	2002	2003	2004	2005
Product cost	66%	47%	48%	69%	42%
Other expenses	50%	57.9%	59.2%	44.8%	40%

It seems that other cost included miscellaneous expenses required for restructuring, because Grot faced serious crisis before bankruptcy in 2005.

However, it should be noted that a manufacturing company should keep indirect expenses (other cost) smaller than direct cost (production cost).

In addition, it matters that earnings of management kept going up for the past five years, while the company did not make profit. Earnings of management should change based on the performance of

the company.

In 2006. Grot made profit before tax of 2,245,000. dinar for the first time after separated from Trepca in 2001.

Table 7.32 Grot Mine Profit & Loss Account in 2006 (1,000dinars)

(Business incomes)		
1. Sales of products		397,533
2. Sales of products		27,740
3. Other business bincome		84
Total		**425,357**
4. Material		108,683
5. Labor charge		139,248
6. Depreciation		41,579
7. Other business expend		134,223
Total		**423,733**
Business profit	**425,357 － 423,733 ＝**	**1,624**
(Other income/non business income)		
8. Financial incomes		5,039
9. Financial expenditures	(－)	7,299
10. Other (non-business) income		2,896
11. Other (non-business) expenditures	(－)	15
Total		621
Profit before tax	**1,624 ＋ 621 ＝**	**2,245**
(Net Profit after tax)		
12. Tax		1,712
13. Refundment tax	(＋)	3,088
Total		**3,621**

(Resources of data : the Grot mining)

The ratio of profit before tax is only around 0.91%, but the fact that Grot turned out to be a profitable company is important. According to the explanation of Grot, this profit is after deducting the debt repayment of 88 million dinar to the private company. Without such debt transferred from Trepca, the Grot would have gained approximately 90 million dinar, which is corresponding 22.6% to sales of products. In this meaning, the Grot changed as a good company owing to the efforts of the new management. The detail of cost is as follows;

Table 7.33 Grot Mine Income and Expenditure Account (Unit : 1,000 dinar)

Production Cost	2006	Other Cost	2006
Material for Production	13,136	Other expenses	14,898
The basic material	43,400	Depreciation	41,579
Supplies	17	Earnings management	39,672
Waste	692	Fuel, lubricating	15,317
Earnings of workers	99,576	Electricity	21,874
Nourishments of employee	5,847	Total	133,340

Transportation expenses	5,103		
Research expenses	13,611		
Total	181,382		
Sales of Products			397,533

① The ratio of production cost to sales products

The ratio of production cost to sales products is around 45.63%、and the ratio of basic materials to sales of products is around 10.9%. Both of them seem to remain at the reasonable level.

② The ratio of other costs to sales products

The ratio of other costs to sales products is 33.5%, which is the lowest for these 6 years. This must be the reason why the profit could be made in 2006. It would be very important for manufacturing companies to reduce the indirect cost. On other hand, the earnings management is increase by 7 million dinar compared to that of 2005, which should be reviewed if reasonable or not.

(2) Advices to the Management of Grot.

In preparing the advices, the interview was made with the management of Rudnik mining that has a very successful result after privatization. The following was a summarization referring to their actual experiences and practices in managing Rudnik mining;

The cost management would be one of the most important factors for manufacturing companies. The main purpose of cost management is to grasp the cost accurately and try to reduce the cost.

The detailed cost list is made and data base management system is adopted at Rudnic mining. They are reviewing and booking every day the costs and making a monthly report submitted to the management. For this data base management, one staff in charge of cost management is assigned at the factory and one accounting expert is appointed to check and analyze it at the head office.

In addition to the normal cost management system, they are trying to reduce the cost by increasing the production volume. It is their policy that the more the production volume is, the less the unit price is. Actually, the product volume in 2006 exceeded that of 1983, when their production volume was the highest. In spite of the production volume increase, the number of workers is to be planned to decrease from 376 to 330. As instructed by the instance of Rudnic mining, it would be possible to reduce the cost by the efforts and trial by the management. It would be suggested and advised to organize a cost

Management committee and make efforts to reduce the cost at Grot mining.

(3) Moral and Discipline of Workers.

One of the most difficult problems the management of Rudnic faced was the moral and discipline of workers. The president director of Rudnic told that not only in mining sectors, but also in all industrial sectors, the management system in 1990's was wrong. As the result of wrong management system, the moral and discipline of works were very poor. Working rules were ignored

by workers and effective production was impossible. It took the management long time to improve the situation. It would be advisable to the management of Grot to make definite employment contract, job description, and working rules and establish a training system in order to improve moral and discipline.

(4) Management System

More difficult problem than the moral and discipline of workers was the management system at Rudnic mining. In the past, when workers participated the management of the companies, and some manager class and high class workers still keeping such mind as they can participate the management and policy making process. Sometimes, they had an objection to the policy of the company and did not follow that. As the result, the management was obliged to fire some managers. It would take long time to change the staff's mind that was familiar with old management system. In order to proceed with the change of their mind smoothly, it would be a good way for the management of Grot to prepare and distribute the educational guidance book on the new management system.

(5) Disposal of Accumulated Debts

In case of Rudnic mining, there is no problem of accumulated debts, because the new owner bought the company with the debt paid off. But, Grot has still problem of accumulated debts, which is disputing in court. The debt is amounting to 15 billion dinar and the management of Grot will not succeed with such heavy debt. Even if the debt is to be decreased to some extent, the heavy debt is expected to remain. The detail of the debts, consisting of 36 creditors, is as shown below and a financial device, such as Debt-Equity Swap, would be required to solve the problem.

Table 7.34 Creditors List for the Grot Mine（Unit：1,000 dinar）

No	Bankruptcy deptor– Law person	CLAIM HIGHT			TOTAL
		Dinars	Devizas	Interest	
1	Shoe factory "Kostana" in bankruptcy, Vranje	158,453.00		43,019.00	201,472.00
2	Company "Vunizol", Surdulica				7,265,390.00
3	Subcontactor "Vrdnik", Vrdnik				90,655,573.82
4	Company "Simpo" for production, market and service	77.040,55 157.715,00 1.287.659,65		6.136.174,20 11.903.450,65 26.975.627,19	45,015,252.04
5	Trade Co. "Trend Kompani", Jagodina	384.653.777,56 + expence of process 66.543,00 and 71.543,00		1760323469,18 and interest on 66.543,00 in a sum of 65.808,57	2,145,181,141.31
6	Trade Co. "Sigma", Pristina Business unit Sigmafarm, Nis			744,545,284.43	765,767,360.39
7	Trade Co. "Jugometal", Beograd	201444,20 44.215,77 111.965,91		interest not accounted	358,376.02
8	Trade Company for inside and outside marketing "Eko–San" Orljane, Doljevac	1.172.016,72 66.170,00		57,166.37	6,970,161.34
9	Insurance Co. "Novi Sad", Novi Sad	421,080.00		interest not accounted	421,080.00
10	Fond for Republic of Serbia development, Belgrade	58,980,522.36		interest not accounted	58,980,522.00
11	Accumulator factory Sombor, Sombor				914,534,925.22
12	Bank "Jugobank", Kosovska Mitrovica				2,472,825,939.41
13	Trade Co. "Jugodent", Nis				19,463,646.00
14	Trande Co. "Jugodent", Nis				10,840,018.00
15	Bank "Invest Banka" in bankruptcy, Belgrade	10,373,352.17			10,373,352.17
16	Agency for deposit asurance, Belgrade	5,614,812.89	46.716,49GBP 127.222,00GBP		5.614.812,89 5.934.365,29 (sum in devizas made into dinars)
17	Bank "Belgrade bank" in bankruptcy, Belgrade	441,740,122.43	5917374,50USD		441.740.122,43 429.920.335,19 (sum in devizas made into dinars)
18	Agryculture commune "Orljane" from Orljane, Doljevac	6,439,606.89			6,439,606.89
19	Trade Co. "Prima–Luks", Nis			1,212,646.98	3,644,338.98
20	Shoe Co. "Mineks", Vranje	6,230,828.00			6,230,828.00
21	Trade Co. "Masinopromet", Vranje	38,213.38			38,213.38
22	Bacery Co. "Vranje', Vranje	128,219.00			128,219.00
23	Trade Co. "Info–Teks", Nis	272,230.00			272,230.00
24	Shoe Co. "Mineks", Vranje	6,965.00			6,965.00
25	Trade Co. "Ilion", Donje Dragovlje	317,376.00		interest not accounted	317,376.00
26	Public Company for electic energy "Electrical Power Supply", Vranje	44,939.39		interest not accounted	44,939.39
27	Trade Co. "Sim–B–Ateks", Sremska Kamenica	41.850,00			41,850.00
28	Bank "Jugobanka", Vranje	192,000.00		interest not accounted	192,000.00
29	"Electrical Power Supply", Belgrade	154,804,779.08		1,444,996,778.20	1,599,801,557.28
30	Ministry for Finance , tax ad	26,770,384.55		116,969.67	26,887,354.22
31	Trade Co. "Komerc", Vranje	not received hight of claim	not received hight of claim	not received hight of claim	not received hight of claim

(6) Projection

It is just two years since the Grot became a company under bankruptcy agency supervision.

But the Grot already turned out the profitable company. Judging from the financial statement, it seems that the Grot could keep such financial situation. It is expected that the Grot prepare the future plan and projection of the company based on the survey of mining potential and production prospect in order to give the incentives to workers and good impression to creditors for advantageous discussion with them.